ORIGINS

The Journal of The Biblical Creation Society

No.22

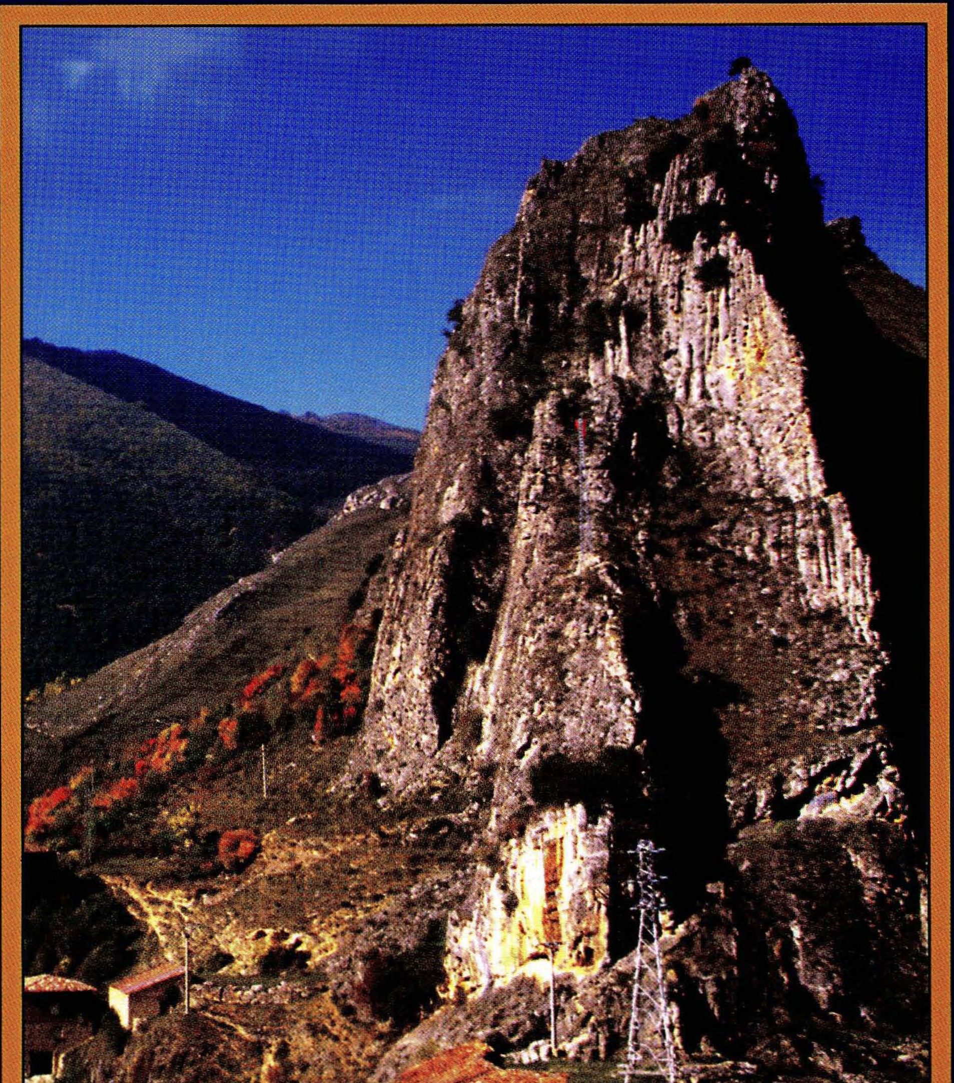
March
1997

Scientific Dating Methods and the Biblical Record

Where was Eden?

Life on Mars?

Flood Geology and the Geological Column



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ORIGINS
• Journal of the Biblical Creation Society •

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Due to pressure on space, several articles have had to be held over to later issues. We apologise to those concerned.

COVER PHOTOGRAPH

Formerly horizontal Jurassic limestone standing vertically in the front part of the Alpine fold at Anguiano, Rioja. *Photograph by Michael Garton.*

Writing for Origins

Origins is looking for talented new writers, particularly those who have had experience in a specialised field of science or theology, in relation to creation, and who are in agreement with the aims and basis of the BCS. In addition, writers in a popular vein are needed, but accuracy and solid content are still essential. Any manuscripts for consideration should ideally be typed, double-spaced and sent to the Editor. Notes of guidance to authors are available on request. News items that may be of interest are also sought. We now welcome articles on disk in most formats, but 3½ ″ HD, Wordperfect 5.1 or ASCII preferred; media will be returned after transfer of the file.

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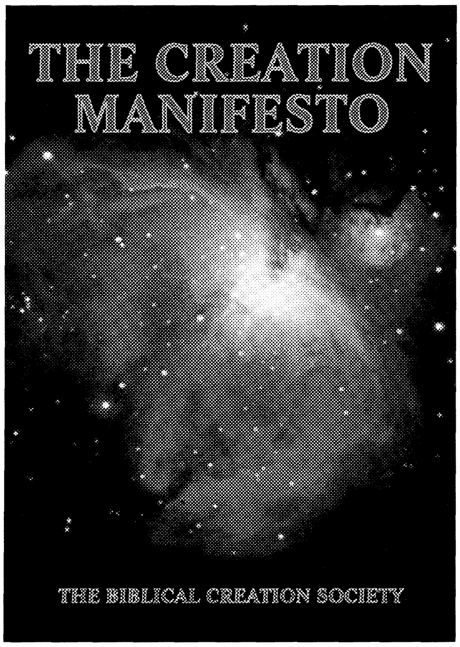
Editorial

WHAT a year it has been. On the one hand I am reminded of 2 Peter 3 and the warnings about the end of the age and the scepticism that will accompany that time. People will deny the reality of Creation and the Flood. Professor Richard Dawkins has made regular appearances on television and radio spreading his atheistic attacks and denying the existence of intelligent design in the living world.

More recently, the head of the Roman Catholic church has formally accepted the possibility of evolution, though with some reservations. As usual, he falls into the trap of other theistic evolutionists of claiming to endorse a scientific approach and yet insists that God had to intervene to give man a soul. So, the approach is not really evolutionary! The folly of compromise. We have no reason to distrust the straightforward record of the Scriptures.

I was interested to see a further example of the effect of Darwinism in a new book by H. J. Pollitt (published by Banner of Truth Trust). It concerns Younghusband, the founder of the 'World Congress of Faiths' and so responsible for the introduction of Eastern mysticism and New Ageism in the church. The author comments, 'Younghusband nourished his mind during his sojourn in the Gobi desert on the works of Darwin, which came to him as a revelation.'

The *Biblical Creation Society* now has a page (or, rather, many pages) on the Internet. You can find us at http://www.pages.org/uk/org/bcs/. Pay us a visit. By the time this Journal reaches you, we should have established a 'hot news' link to enable us to react quickly to news items of interest, like the report about the supposed discovery of 'Life on Mars'.



THE CREATION MANIFESTO

THE BIBLICAL CREATION SOCIETY

We have republished our *Creation Manifesto.* Members will receive a copy; more are available from the *BCS* office at £1.50. Please distribute this widely. Prayerfully consider to whom you could give a copy. This *Manifesto* makes it clear where this Society stands. We are not accountable for any other views from within the creationist movement, though we would anticipate that there is widespread agreement amongst us. Contributors to the Journal will be expected to confirm that they accept our Basis of Faith *and* the Manifesto. All articles must be in accord with these two statements.

In this issue we publish a joint statement from geologists from Europe, Australia and America on the *Geological Record.* This statement also describes a basic position being adopted by the signatories. This is a working statement which we expect to develop, improve and revise and it outlines the basis for our research in this area. It will, however, be clear from this statement that we are unlikely to consider any paper for publication that denies the validity of the geological column *per se.*

Michael Garton has contributed a report on a visit made by creationists from various UK groups to Spain. In the course of the article he describes the position adopted by the *BCS* committee in interpreting the geological record. This can be summed up as follows:—

The evidence suggests that, following a destructive and violent global Flood in the Palæozoic, the Flood ended at the time of the Carboniferous strata. The continents stood high and dry during the Triassic, and thereafter more than half of the land surface has always remained above the waves. That there was continuing, and substantial, global activity after the Flood was no surprise; the earth had been denuded and left unstable by the events which caused the cataclysm. The earth needed time to recover and settle down.

As Michael says, this is a basis for research and some details may be adjusted with time. As one of those who took part in this trip, I would pay tribute to Michael for the work he put in by way of organisation. It *was* hard work, but worth every minute of it. Watch out for more opportunities to be offered through the *BCS*, the first being a return visit to Rioja in May 1997.

J.H.J.P.

JOURNAL ALERT

A new resource for members of the BCS

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The Bible and Chronology

4: A Geochronological View

J. H. John Peet

PREVIOUS articles in this series have reviewed the biblical and archæological data concerning the chronology of earth history. We have sought to identify the basic parameters set by the Bible and how these can be correlated with the archæological findings. From these studies we have demonstrated the historical nature of the biblical record.

We have seen that it is difficult to justify an age for the world much in excess of 7,000 years. Similarly, the Noahic Flood would have been less than 5,000 years ago (Peet, 1994; 1995a; 1995b). A recent book by John Morris shows that the biblical data could suggest dates of up to 12,000 and 10,000 years ago respectively (Morris, 1994) if we consider the various ancient texts.

Figure 1: According to Bishop Ussher, this is the 6000th year since the Creation. Is he right?

The dates are approximate, as demonstrated in the papers, but they do define the order of magnitude which young earth creationists have to accept if they are to be consistent with the biblical data. We have shown that the biblical data can be correlated with the historical archæological data. What of the geological data which are usually seen as referring to an earlier period in earth history?

In a useful series of papers in *Origins*, Michael Garton (1990a, 1990b, 1991a, 1991b, 1993a) has demonstrated that the geological data are consistent with the biblical record of the Flood and its immediate aftermath. Table 1 is a typical analysis of this correlation, though the details are still the subject of research (Garton, 1996b). Bernard Northrup (1979) has circulated papers based on an alternative time scale, but the principle is similar.

Perhaps we can express the problems most succinctly by referring to Egyptian history and the geological timescale. Much research is being conducted by creationists in these areas and the final explanations have yet to be given. We can, however, begin to see our way forward and recognize that the problems are less intractable than many believe.

Egyptian Roots

Under the conventional time-frame for Egypt, the earliest human skeleton is dated to more than 10,000 years ago and the earliest stone tools to over one million years (in the Lower Pleistocene). The Egyptian civilisation is the oldest after that of Mesopotamia. The Sumerian region was flooded (post-Noah) in the Jurassic and Cretaceous periods, so forcing the scattering of the people. This can probably be correlated with the times of Peleg and Babel (Genesis 10:25; 11:8) (Robinson, 1995).

In terms of human population density, there is little to inhibit a vast reduction in the time scale for Egyptian history. The questions are whether we can reduce the geological timescale to a few hundred years and whether the result is consistent with Egyptian history. Robinson (1995) believes that the answer to both questions is in the affirmative[1]. He demonstrates that this is possible, not only by studying the geology of the region, but also in terms of the rate of population growth.

The first pharaoh, Narmer, has an inscription recording a census of 120,000 men. The population was, therefore, probably around half a million. Are 300 years sufficient for a growth from the first migrants to this population? Undoubtedly. When Jacob moved into Egypt, he took seventy people (Exodus 1:5). After 430 years, the population had reached the two million mark. Half a million is, therefore, a very realistic estimate for three hundred years of inhabitation. The conventional model would require the population to have reached many millions during this geological period.

During the Mesozoic era, northern Egypt was still covered with the seas which spread around the continental margins (Garton, 1993b). Geological maps (see Figure 2) show the shore line to have been some 300 km (*ca.* 200 miles) south of the present Nile delta. However, most of Egypt would have been dry land and the first immigrants could have settled somewhere in the south, though conditions were not very hospitable. The maximum transgression of the sea was in the Lower Eocene during which limestone was deposited (see Table 2 for a list of the geological periods).

The retreat of the seas began in the Middle Eocene, gathering speed during the Upper Eocene. As this continued into the Oligocene, the land rose generating catastrophic drainage. This is demonstrated by the presence of fossilized trees. The first mammalian evidence occurs here. The flow of the seas caused massive erosion in the Nile area as the Mediterranean basin was drained out in the Miocene period. The Mediterranean was refilled during the Pliocene and marine sediment filled the Nile canyons.

As the earth moved through the Tertiary period, there were brief flooding events during the periods of torrential rain. At this time, the Sahara was fertile and inhabited. The Nile excavated its old course through the Pliocene sediment. The earliest man-made tools appear in this time period. Herodotus records that Egypt was still a swamp at the time of the Pharaoh Menes.

Robinson (1995) dates the Jurassic from 2900 BC. He estimates that a population of seventy entering Egypt in the Jurassic period would reach a quarter of a million by the time of the first dynasty.

The Geological Timescale

The arguments in favour of a much reduced timescale have been discussed before in our Journal (Garton, 1993a; Scheven, 1990). Table 1 shows the sort of timescale that young earth creationists need to be considering. As in any research, the figures assigned are open to further debate, but these would be consistent with the biblical picture.

It will be observed that this model does not attribute all of the geological strata to the year of the Flood. According to the Bible, the Flood was global and catastrophic. Some people argue for something less dramatic, but it is clear that God describes it in these all-inclusive terms: 'I will blot out … every living thing' (Genesis 7:4). The term is that used to describe the total eradication of our sins (Psalm 51:1). The account goes on to refer to 'all flesh … every swarming thing … all mankind … Thus He blotted out every living thing.' (Genesis 7:21–23). In fact, if God had intended to say that the Flood was global in extent, He could not have said it more plainly! We find that the Palæozoic rocks are global in extent. So, we conclude, these rocks represent the Flood year.

The account also tells us all air-breathing land animals were blotted out in the first forty days of that year (Genesis 7:12, 17–23). With a flood of these catastrophic proportions it was impossible for life to survive more than these few weeks, if that long. Michael Garton (1996a) has described how footprints of air-breathers are observed only in later strata. Obviously such creatures must have been alive. Paul Garner (1996a) has been researching dinosaur egg nests in the Mesozoic period. Again, the parents had to be alive to lay the eggs. These rock formations cannot, therefore, apply to the Flood year—the animals were either dead at this time or safe in the Ark (Robinson, 1996a; Tyler, 1996). These strata must have been laid then, after the Flood had subsided and the animals from the Ark had repopulated the earth.[2] See also Garner (1996b) and Scheven (1996).

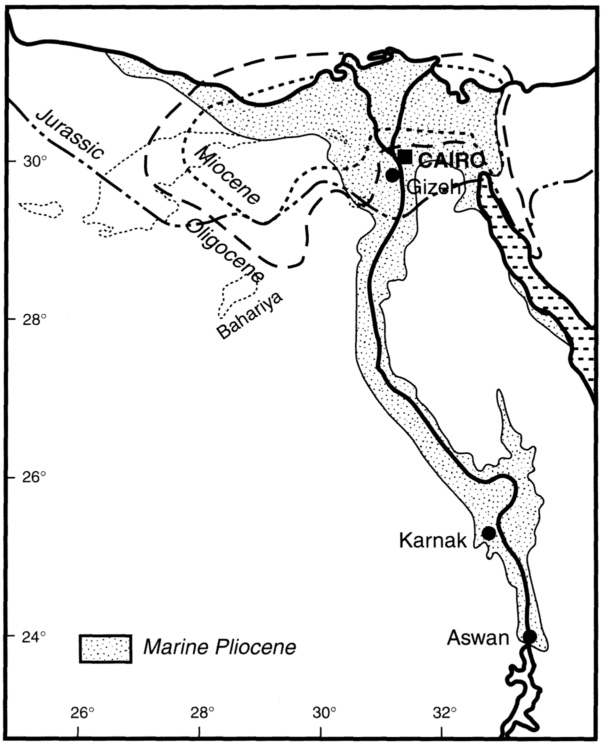


Figure 2: Encroachment of Seas in Egypt

We know that following modern earthquakes and volcanic eruptions, the after-shocks can be significant and last for a long time. A catastrophic event of the scale of the Noahic Flood must have had dramatic results, which probably included continental break-up. (There was, of course, more than one such event: a supercontinent broke up during the Flood and reassembled to form Pangæa. This, in turn broke up in the post-Flood times). Figure 3 illustrates a *damped sinusoidal wave.* After the initial event of a large amplitude, the subsequent events occur at intervals but with reducing effect. The nature of the after-effects of the Flood would have been more complex and multi-

Cenozoic era	Quaternary	500+ to 4000 years post-Flood	
	Tertiary	100 to 500+ years post-Flood	
Mesozoic era	Cretaceous Jurassic Triassic	Probably 50 to 100 years post-Flood	
Palæozoic era	Permian	Dry land	Genesis 8:13–14
	Carboniferous	Coming and going of waters	
	Devonian	Land emerges	Genesis 8:3
	Silurian	Total submergence	Genesis 7:24
	Ordovician Cambrian	Violent inundation	Genesis 7:12
Precambrian era	Proterozoic	The beginning of the Flood?	
	Archæozoic	Creation week	Genesis 1:1–2
	Azoic		

Table 1: One possible correlation of the biblical record and geological strata

Cenozoic	Quaternary	Holocene Pleistocene
	Tertiary	Pliocene Miocene Oligocene Eocene Palæocene
Mesozoic		Cretaceous Jurassic Triassic

Table 2: The Geological Periods of the Mesozoic/Cenozoic Eras

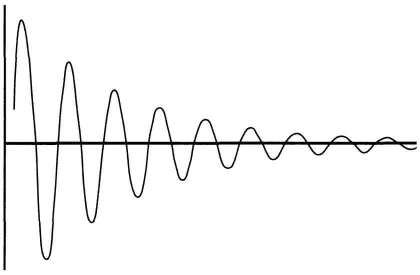


Figure 3: A damped sinusoidal wave.

dimensional, but the principle would be similar. The geological disturbances of the present day are a continuing fall-out from that original event.

The Ice Age would have been another natural consequence. Non-catastrophic models of the Ice Age are unsuccessful as explanatory tools. In the modern age, ice is formed during cold winters and thaws during the summer. The ice fields can be seen to be retreating rapidly around the present world. So, how did they grow year on year? How was sufficient precipitation achieved and how was the thawing prevented?

Oard (1990), a meteorologist, has researched this and produced a computer simulation based on the Flood effects which fits our observations. The underground waters of the Flood period and the volcanic activity of the continental rifting would have raised the sea temperatures and encouraged greater evaporation and more precipitation. The volcanic activity would have caused extensive dust clouds which would have excluded sunlight, preventing summers over a long period.

Another effect of this ice period would have been in the loss of adequate vegetation and so vitamin deficiency. Those living at the ice face in Europe (*e.g.* Neander Valley, Germany) would inevitably show signs of such vitamin deficiency.

What About the Clocks?

If we accept this revised timescale as geologically feasible and the archæological/geological history of Egypt as consistent with it, we are left with another problem. Do the radiometric clocks not confirm the evolutionist's timescale for geological history?

To answer this, we need to distinguish between two kinds of material which are used for dating purposes: those of organic origin and those which are inorganic. The former are studied using the carbon-14 isotope and the latter are based on the other elements such as potassium, uranium, rubidium, *etc.* These two groups of elements differ in their origin and timescale. Carbon-14 is used to measure objects of a few thousand years of age, whereas the inorganic materials would only be effective if the ages were of the order of millions of years or greater.

There is a further problem which is often not appreciated. The rocks which contain the fossils, the sedimentary rocks, are usually not suitable for radiometric dating. These are reworked rocks and so any associated radiometric age will refer to their origin and not their present circumstance. Igneous (volcanic) and metamorphic rocks are used because the date obtained will, apparently, refer to their formation. However, such rocks do not contain fossils—the fossils would be destroyed by the process involved. At best—but see below—fossils may be dated by their position relative to these rocks. For example, the bones of so-called *Australopithecus ramidus* (Anon, 1995) were found to be lying on top of igneous material dated to about four million years of age. So, these bones had to be younger than that.

The principle behind radiometric dating is fairly simple. We can illustrate it by reference to a candle which is found burning in a room. From the present and original sizes of the candle and the rate at which it is burning, we can calculate how long it has been alight. For example, consider the case when it is 4 cm long and was originally 10 cm in length. If it is burning at the rate of 1 cm an hour, then the 6 cm that have disappeared would have taken (6 cm) / (1 cm/hour) = 6 hours.

But, there are several possible sources of doubt or error here. How do we know that it was 10 cm long originally? How do we know it was always burning at the same rate? (A draught could cause it to burn faster!) If we do not know the original length, we could (theoretically) collect all the soot and fumes formed and weigh them. That would enable us to determine the weight lost (and so length) of the candle. But, we would have to be sure none escaped and that there was no soot in the room already!

The same principle is true for radiometric dating. We need to know the rate of decay and the original amount of material. If we cannot know that (because the event was long before scientists measured it!), then we must know how much material was formed from it. Even then, as with the candle, we must be sure that none of that material escaped.

In the following discussions, we are assuming that the rate of decay is constant. Though variations can be achieved, they have always been of minor significance and would have no meaningful effect on the calculated ages. Probably the only factor that would affect it would be a substantial variation in the velocity of light (Norman and Setterfield, 1987; Peet, 1990; Reeves, 1992). A significant increase in the speed of light would not only produce a significant increase in the rate of decay, but also of the amount of background radiation from the rocks. This would have been seriously injurious to health and so is seemingly inconsistent with the early biblical history.

The key expression for any calculation of the radiometric age of a specimen is

$$A_t = A_o.e^{(-0{\cdot}693/t_{1/2})t}$$

or,

$$t = \frac{t_{1/2}}{0{\cdot}693} \,.\, ln \frac{(A_t)}{A_o} \qquad \ldots \text{ equation (1)}$$

where t is the time that has passed since the original amount of radioactive material (A_o) has decayed into the measured amount (A_t). The term $t_{1/2}$ is called the half-life[3] of the isotope being studied. *ln* is a mathematical term indicating that we use the *natural logarithm* of the number in the bracket. The basic problem is that we cannot solve the equation because we do not know A_o. But, do not despair: scientists have more than one way of approaching the problem!

(a) Organic Materials

Living organisms contain the element carbon as an essential part of most of their compounds. Carbon exists primarily as the isotope carbon-12. (An isotope is a form of an element with a particular relative atomic mass, in this case, 12 units). There is also a small amount of another isotope, carbon-14. This form is radioactive. The level of activity from a carbon compound is in proportion to the amount of carbon-14 present.

While an animal or plant is alive, it is taking in carbon through its diet. This will be a mixture of the two isotopes. When the animal or plant dies, it takes in no more food and so no more carbon. Carbon-12 is a stable isotope, so the proportion of that will not change after death. Carbon-14 slowly decays away with a half-life of 5370 years. So, the ratio of the isotopes in a dead creature, $(^{14}C/^{12}C)_{dead}$, will gradually decrease. In general, we can say that, after ten half-lives (60,000 years), the carbon-14 will be undetectable. The method can, therefore, only determine the 'age' of creatures, *etc.* that died within the last 60,000 years.

Figure 4 shows the principle behind this technique. The value at the time of death, $(^{14}C/^{12}C)_0$, gradually reduces due to radioactive decay. When we find the sample, we get a new value, $(^{14}C/^{12}C)_t$. From this graph we can calculate how many years have passed (t) since the object died.

But, we need to know the initial value, $(^{14}C/^{12}C)_0$, in order to plot the graph. This is the critical point in the application of the technique. We need to consider the way and rate at which carbon-14 is produced in the atmosphere. It is formed by the effect of cosmic radiation on our atmosphere. It is possible to measure the rate of this reaction.

However, as it is formed, some of it will decay (Figure 4). The net result is the graph in Figure 5. It will be observed that, after a while (t_e years), equilibrium is established: the rate of production equals the rate of decay. So, there is a balance between the two processes and no net change in the level of carbon-14 in the atmosphere. The value, t_e, is 60,000 years.

Consequently, if the earth is more than 60,000 years old, this value is stable and we can say that $(^{14}C/^{12}C)_0$ is the same as that in the present atmosphere. All we need then is to plot Figure 4 using the present atmospheric value as our starting point.

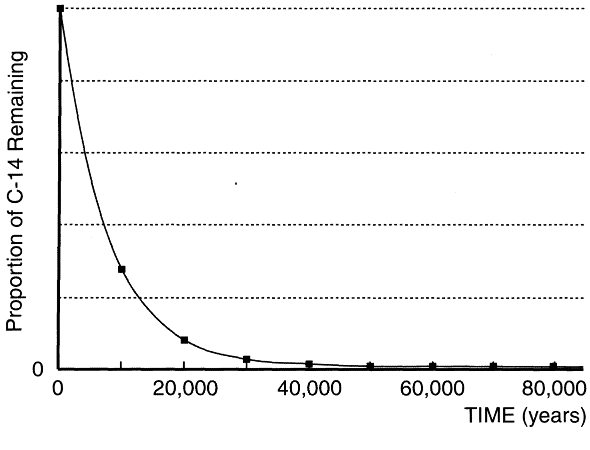


Figure 4: Decay Curve for Carbon-14

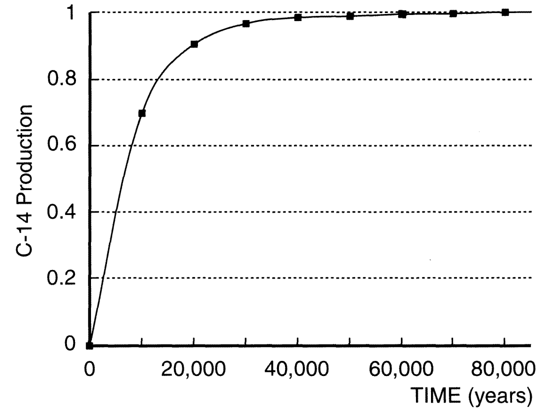


Figure 5: Net Growth Curve for Carbon-14

Of course, if the world is younger than the 60,000 years, then we will not have reached equilibrium. The question becomes: is the amount of carbon-14 in the atmosphere at this equilibrium level? The answer is no. There is a discrepancy of at least 16% (see Figure 6). We must conclude that the earth is no more than about 10,000 years old. Also, this means that we cannot use the current atmospheric value as $(^{14}C/^{12}C)_0$. (Knowing this discrepancy, we can recalculate the age of the samples, of course). We are grateful to David Tyler (1977, 1978) for his valuable research into this.

Carbon-14 dating, therefore, could only work if an object was less than 60,000 years old. In practice, because of this non-equilibrium situation, the age must be limited to a maximum of about 10,000 years (See Appendix 1).

Isotope ('Parent')	Half-life	Product ('Daughter')
Potassium-40	$1{\cdot}30 \times 10^9$ y	Argon-40
Uranium-238	$4{\cdot}55 \times 10^9$ y	Lead-206
Uranium-235	$0{\cdot}71 \times 10^9$ y	Lead-207
Thorium-232	$13{\cdot}4 \times 10^9$ y	Lead-208
Rubidium-87	$48{\cdot}8 \times 10^9$ y	Strontium-87

Table 3 : Some isotopes commonly used in radiochronology

(b) Inorganic Materials

Rocks, however, consist of elements other than carbon. The key constituents are the metallic elements. Some of these have radioactive isotopes and so can be used to determine the age of a sample. Table 3 lists some of the commonly used isotopes.

Obviously, applying the principle described earlier, these elements will still be around up to 10×10^9 years (ten half-lives), a figure well in excess of the supposed age of the earth. Again, all we need to do is compare the current figures and the original figures for igneous rocks and we can estimate the 'age' of the rock, that is, the time since it was formed.

A basic principle in scientific measurement is that any method of measurement should be calibrated. So, if a scientist is seeking to determine, for example, the amount of lead pollution in the grass near a motorway using an instrument,

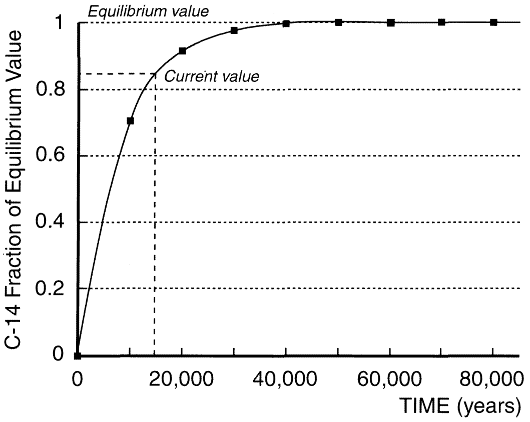


Figure 6: True Growth Curve for Carbon-14

he would first make a set of solutions of lead of exactly known concentration. He would check the reading on the meter against these standards and so produce a calibration graph. Using this graph and the meter readings for the grass sample, the true concentration can be found.

With the radiocarbon system, the dates can be calibrated against known historical events (up to, say, 4,000 years ago). This is not possible with the radiometric methods based on inorganic materials—there are no fixed, independent, conventional geological dates available for calibration purposes. Of course, we might argue for calibration against geological events in the Bible. This would be an excellent basis, but it does require agreement on how these can be synchronised. Without calibration, the interpretation of the data is unreliable.

Another basic problem in using these techniques based on inorganic materials is that we do not have any information on the amount originally present and no way of estimating it directly from present day values. There are various ways in which the original values may, in principle, be estimated. For the sake of clarity for the non-scientist, the underlying details of the techniques are provided in the boxes (1–3). We will look at each method in turn to see what it can tell us.

Potassium–Argon Dating

Potassium–argon dating is based on a simple principle. As potassium-40 decays, it generates argon-40. As indicated in Box 1, we can use these values to determine the apparent age.

The method assumes that *(a)* no argon (or potassium) has leaked out of the rock and *(b)* no argon (or potassium) has entered the rock from any other sources. It is difficult to identify whether either of these has occurred except by comparing the value obtained with the true age. Usually, of course, that is what we are trying to find! However, we can calibrate the method against some known examples (Table 4). From these, we conclude that igneous rocks retain excess argon (for example) from below the earth's crust and so we cannot use this technique to determine ages.

Box 1: Potassium–Argon Dating.

Potassium-40 decays by two processes:

$$^{40}K + e^- \rightarrow {}^{40}Ar$$

and

$$^{40}K \rightarrow {}^{40}Ca + e^-$$

but the former is the more extensive.

For every atom of potassium, one atom of the gas is produced. So, the current amount of potassium-40 tells us how much of the element is left. The amount of argon-40 will tell us how much of the potassium has decayed. We can, therefore, calculate A_t *and* A_0 in the equation 1 in the main text (page 4). Since we know $t_{1/2}$ (table 3), we can calculate the apparent age of the rock.

A number of problems are noted in the article. In addition, we find that there is more argon-40 in the earth's crust and atmosphere than would be expected even from the conventional geological age of the planet.

Argon loss can occur because of the inability of the mineral lattice to hold the gas if there has been a partial melting and recrystallization of the rock, because of metamorphism, by chemical weathering, through the solution and recrystallization of water-soluble minerals or as a result of physical damage to the rocks.

Before any potassium–argon age can be quoted, these factors (and others reflecting argon gain or potassium change) must be eliminated or estimated. It is not sufficient to accept a date because it fits the figure expected.

Uranium/Thorium–Lead Dating

Uranium- and thorium-containing rocks can be studied by comparing the amounts of these elements with the amount of lead produced by their radioactive decay. As with the previous technique, we have to assume that there has been no movement of isotopes into or out of the rock (*i.e.* that it is a 'closed system'). The advantage of this method is that it can be self-checking: the different isotopes of the parent elements (uranium and thorium) should generate the same age for the rock. In general, however, they do not.

Zircon crystals have been studied by this process. An interesting observation has been the result of ion microprobe studies. They demonstrate that the parent and daughter isotopes occur in different parts of the crystal lattice and so the lead

Location	True age	Radiometric age	Reference
Sunset Crater, Arizona	900 years	220,000 years	Dalrymple, 1969
Rangitoto, New Zealand	< 300 years	485,000 years	McDougall, 1969
Vulcan's Throne, Grand Canyon	<10,000 years	117,000,000 years	Damon, 1967
Hualalai, Hawaii	170 years	140,000,000 –2,960,000,000 years	Funkhouser & Naughton, 1968
Salt Lake Crater, Oahu	<400,000 years	3,000,000,000 years	Funkhouser & Naughton, 1968
Kilauea, Hawaii	<200 years	21,000,000 years	Noble & Naughton, 1968

Table 4 : Calibration data for potassium–argon dating

Box 2: Uranium/Thorium–Lead Dating.

Two different isotopes of uranium (mass numbers 238 and 235) and one of thorium (232) decay into different isotopes of lead (206, 207 and 208 respectively). Though the decay chains are relatively long, only the first step is significant chronologically (unless the earth is young), since all the other steps are much more rapid. The amounts of each isotope are measured relative to the non-radiogenic, and so unchanging, lead-204 isotope.

Even though each of the parent isotopes may be present in a rock specimen, there is usually no consistent age profile. These inconsistent (or disconcordant) values lie on a straight line in the graph. Such discordancy is found predominantly in metamorphosed rock. This discordancy also indicates that the system is not closed—there must have been lead loss.

(the daughter) could not have come from the uranium decay.

Gale *et al.* (1972) open their paper with the comment, 'It is not widely appreciated, outside the ranks of those who work directly in geochronology or meteoritics, that, judged by modern standards, the meteorite lead–lead isochron is very poorly established ... There is insufficient uranium and thorium to explain the observed development of radiogenic lead.'

Rubidium–Strontium Dating

Rubidium–strontium dating makes use of another means of compensating for the unknown initial amount of strontium-87. It would seem that these rocks always contained some of this isotope at the time of formation. The question is, how much?

As indicated in Box 3, we can study different portions of the rock and plot the ratios ($^{87}Sr/^{86}Sr$) and ($^{87}Rb/^{86}Sr$) against each other. If these specimens were formed at the same time, then the slope of the line gives the age of the rock. The advantage of this method is that we do not need to make any assumption about the original composition of the rock (though it may be deduced from the graph).

In spite of the reasonable theoretical arguments in support of the method, it does not always generate meaningful results. Austin (1994) has found an anomalous feature of the technique. He studied igneous formations in the Grand Canyon. The Precambrian metamorphic and igneous rocks deep in the Canyon are the oldest strata. The Quaternary lava flows on the Uinkaret Plateau are the youngest igneous formations and were ejected after the sedimentary strata were laid and the canyon eroded. While the Precambrian rocks are conventionally dated at over 600 million years, the Uinkaret flow is understood to be only several millennia in age. Austin obtained several interesting measurements (Table 5). The rubidium–strontium isochron predicted an age of 1,340 million years for the Uinkaret basalt rather than one of less than 10,000 years.

The rubidium–strontium system can also be affected by chemical weathering which removes strontium. Different minerals in the rocks are affected differently in this respect. Bath (1974) reports that 'Silurian shales from Pembrokeshire and the west Borderlands [have] shown that such rocks can define isochrons giving ages significantly younger than the time of deposition adduced from faunal evidence.' He suggests that this is due to dewatering and ion transport.

It is possible to get similar linear plots for functions which are not time dependent. For example, the iron isotopes are not related radiometrically and yet a plot of $^{54}Fe/^{86}Sr$ against $^{58}Fe/^{86}Sr$ is linear. Another problem is in the report by Tilton and Barreio (1980) that some isochrons give negative slopes and so, by implication, negative ages! Snelling (1995) has also discussed the existence of false isochrons from Koongarra in Australia. He shows that the isochron age has no geological meaning, the deposit showing ample evidence of being an open system. He believes that open systems are the norm. As

Box 3: Rubidium–Strontium Dating.

The rock will contain a large number of crystals formed more or less simultaneously. The amount of rubidium and strontium in each crystal may vary. The amount of rubidium-87 left and the amount of strontium-87 produced will, therefore, be different in the different crystals. We can compare the amount of these isotopes to the amount of non-radioactive strontium-86. Since the amount of the latter isotope will not have changed, it gives a means of comparison between the different crystals. Though these ratios are different, the ages of the crystals are the same.

This can be described mathematically as

$$\left[\frac{^{87}Sr}{^{86}Sr}\right]_t = \left[\frac{^{87}Sr}{^{86}Sr}\right]_o + \left[\frac{^{87}Rb}{^{86}Sr}\right]_t (e^{\lambda t} - 1)$$

that is, the relative amounts of ^{87}Sr at the present time (t) and originally (o) and the relative amount of rubidium-87 at the present time. (See Appendix 2 for the derivation of this equation).

Three rock samples A, B and C with different proportions of ^{87}Rb have, at the time of formation, the same amounts of $(^{87}Sr)_o$ (Figure A). Note the assumption. After a period of time, t, the ^{87}Rb in each will have decayed to the new values A′, B′ and C′ (Figure B).

The longer the period of decay, the greater the slope.

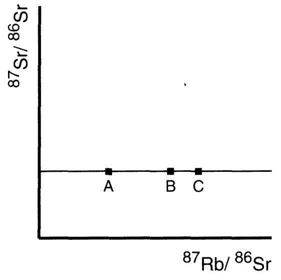


Figure A

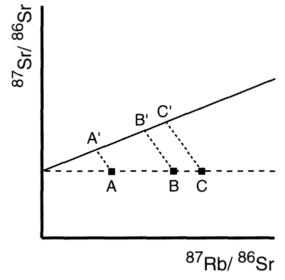


Figure B

Method	Uinkaret Plateau Basalt	Cardenas Precambrian Basalt	Diabase Precambrian Basalt
K–Ar model	0·01–117 Ma	791–853 Ma	914–954 Ma
Rb–Sr model	1270–1390 Ma	980–1100 Ma	850–1370 Ma
K–Ar isochron		715 Ma	
Rb–Sr isochron	1340 Ma	1070 Ma	1070 Ma
Pb–Pb isochron	2600 Ma		

Table 5 : Radiometric measurements on Grand Canyon basalts.

reasoned below, we must find a more adequate model for the interpretation of this data.

Young Earth Position

If we accept the biblical timescale, we will be faced with a different expectation. Rocks that formed at the time of the Flood will be less than 5,000 years old. For the inorganic materials, the amount of the daughter products generated will be negligible. This is apparently in complete contrast and contradiction to the experimental data. If we assume that the Flood occurred about 5,000 years ago (for a round figure), there would be no measurable decay in this period of time. For example, if the half-life of an isotope is 500 million years, then (from our earlier equation)

$$\frac{A_t}{A_o} = e^{\frac{-0{\cdot}693 \times 5000}{500 \times 10^6}}$$

i.e. A_t is 99·9993% of the initial activity, A_o, a difference far below the experimental uncertainty level in radiometric measurements.

Carbon-14 dating should give measurable dates for this shorter timescale, but, as we have seen, the experimental data can only be understood in the biblical time-frame, bearing in mind the non-equilibrium situation described.

There are a number of natural features that are consistent with the young-earth position. Briefly, these can be identified as in Table 6.

1. Surface features, e.g. ripple marks, rain drops, animal tracks
2. Deficiency in bioturbation
3. Lack of soil layers
4. Undisturbed bedding planes
5. Polystrate fossils
6. Limited extent of uniformities
7. Soft sediment deformation

Table 6 : Geological evidence for a young earth (Morris, 1994, chapter 8)

Yet, in spite of this supportive evidence, there is clearly a *prima facie* case from inorganic radiometric methods for an old earth position. We need to remember that experimental data are not dates. The dates are interpretations of the data. Though, as we have seen, they are based on good scientific principles, they are neither wholly reliable and consistent, nor are they in accord with the biblical data. We need an interpretative model that is able to correlate the data with these two aspects. Ideally, the model should be able to interpret these experimental data, take into account all possible sources of error, explain previously unexpected results and generate chronological information consistent with the biblical model.

It is easy to be dismissive of the interpretations because of the false presumptions of the investigators or because of the selectivity of the data published. However, it is still the case that the order of magnitude of the derived dates fits the old earth model. An interesting piece of research was that by Huff *et al.* (1992). They examined the volcanic ash of the Ordovician strata on the east coast of North America and also in northwest Europe (Sweden). If the continental rifting model is correct, then these were part of the same chronological and geological deposit. Huff and his colleagues compared the chemical nature and radiometric dating of these beds. The chemical fingerprinting of them establishes a common origin of the bentonite. The dates derived also conform to the old earth model (Table 7).

Method	Sweden	USA
^{40}Ar/^{39}Ar	455·0 Ma	454·1 Ma
^{238}U/^{206}Pb	452·0 Ma	
^{207}Pb/^{206}Pb	456·0 Ma	453·7 Ma

Table 7 : Radiometric ages of an Ordovician volcanic ash.

Although, as has been shown elsewhere, there is often some selectivity in the publication of the data generally, there is no reason to believe that has occurred in *this* case. In any case, the general agreement in these data is impressive.

Any interpretation of scientific data is based on certain presuppositions. Our position is obviously based on a model related to the biblical account: an original creation in excess of 6,000 years ago, followed by an early fall of man into sin with a consequent judgment on the earth (Genesis 3:17–18; Romans 8:19–22).[4] Then, probably some fifteen hundred years later, a Flood (with its subsequent effects[5]) completely altered the planet's geological history. The old earth model has its own set of constraints. These are more apparent when the data obtained are 'anomalous' within this model. In particular, it is assumed that the rock represents a 'closed system' unless the data are inconsistent with this. A closed system is one in which material neither enters nor leaves the rock. We have already seen (page 6) that volcanic rocks tend to trap inert gases from inside the earth. Also, material may escape, for example, by leaching. So the systems are not closed.

So, how can we correlate these opposite positions? One alternative explanation is the 'mixing model'. This has been proposed by a number of researchers, both creationists and non-creationists (Andrews, 1976, 1980; Arndts, Overn, Bartz, Kramer, 1983; Matsuda, 1974; Zheng, 1989). Arndts and his colleagues point out that if one mineral sample has a ^{87}Sr/^{86}Sr value of 0·7105 and another has a value of 0·7050 due to mixing, then they will have an appearance of age by the isochron technique. This is inevitable. In order to distinguish between the apparent age and mixing models, they proposed that the ^{87}Sr/^{86}Sr ratio should be plotted against 1/Sr, that is, the reciprocal of the total strontium content. If the result is linear, it would demonstrate that the ratio is dependent on the strontium concentration rather than age. They applied this to a number of published examples and found that a significant proportion gave linear plots based on the concentration principle. My concern is that the data are not always unambiguous. They quote correlation coefficients which are not, of themselves, always significant support for their model.

The following example is taken at random and concerns an ancient granite from southern Africa. Table 8 gives the data and Figures 7 and 8 are the isochron and mixing plots.

The apparent age (from the isochron, Figure 7) is $3{\cdot}2 \times 10^9$ years. The mixing line based on the model proposed by Arndts *et al.* is not satisfactory. The fifth point deviates significantly from the straight line plot. Obviously the model is not entirely adequate.

Similarly, Snelling (1995) commented on his research on the Koongarra deposits in Australia, 'It strains all credulity to suggest that a false 'isochron' through a data set derived from samples representing a variety of rock types, of significantly different evolutionary 'ages', over an area of up to 17 km lateral extent from the known radiogenic Pb source, can still represent mixing!'

We have mentioned previously that a linear plot can be obtained for isotopes that are not related radiometrically. Jager, Hunziker and Kazmann (1978) wrote, 'Many lead isotope studies ... have revealed the presence of linear arrays of data points ... They may be mixing lines or have the significance of isochrons.'

So, the mixing model is as likely as the isochron model, bearing in mind that the latter has a number of problems of interpretation. The mixing model is clearly possible and makes sense in igneous rock formation. But, why does it give a gradient which is usually consistent with the values proposed by the old earth model?

What is the significance of this 'old earth age' value? Unless we can find an alternative adequate explanation of this apparent consistency in the experimental data, we must accept the implied extent of decay. We are also faced with the fact that all short half-life isotopes have apparently decayed away, whereas a young earth model would expect some of them to still be around.[6]

Sample	^{87}Sr/^{86}Sr	^{86}Sr (μg per gram rock)	^{87}Rb/^{86}Sr	Total Sr (μg per gram rock)	1/Sr
1	0·753	32·2	0·934	56·5	0·018
2	0·789	26·7	1·729	47·8	0·021
3	0·862	17·3	3·321	32·2	0·031
4	0·915	13·7	4·488	26·2	0·038
5	1·089	12·1	8·321	25·3	0·040

Table 8 : Analytical data for a southern African granite

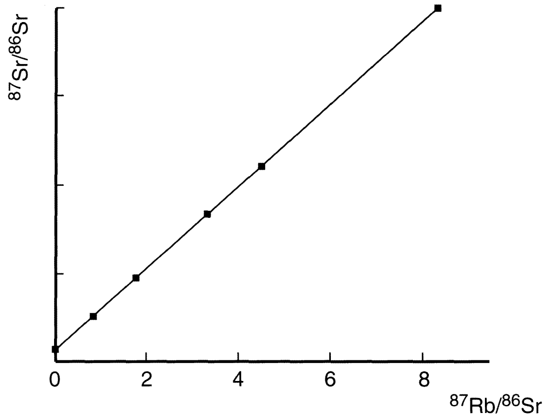


Figure 7: Isochron data curve

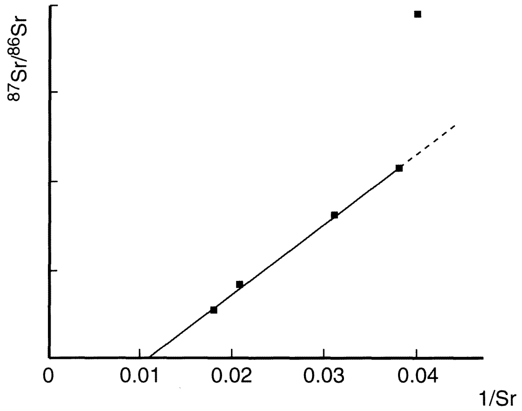


Figure 8: Mixing data curve

It is possible that the earth is very old. But that appears to us to be precluded by a natural reading of the Scriptures. Some would suggest that there is a time gap between Genesis 1:1 and 1:2—that is, between God creating the heavens and the earth (verse 1) and His filling them (in subsequent verses).[7] We are not persuaded that this is the correct exegesis of these verses nor would it account for fossilization of life not yet created. Another explanation may be that the rate of decay was, at one time, greater than it is today. We have already noted that this would be impossible during the period of the living organisms because of the toxic implications. But, could it be that this accelerated rate of decay occurred during the first part of the Creation week as one of the natural consequences of the creation process? This would probably be consistent with the model proposed by Russell Humphreys (1994) in 'Starlight and Time'. Further research is needed in this area.

Radiohalos

There is another area of research which would seem to be relevant to this hypothesis. Gentry (1973, 1974, 1992) has studied the phenomenon of 'radiohalos'. They are found in Precambrian granites and coalified wood and are due to the ionising properties of radiation. Only α-radiation gives rise to the halos, which are areas of discolouration in the rock. The discolouration is circular in cross-section since the radiation moves out equally in every direction from a central source. The energy of the radiation is different for each isotope. For example, the energies of the isotopes of uranium are distinctive:

^{238}U, 4·19 MeV
^{234}U, 4·77 MeV.

The distance travelled by the radiation is dependent on its energy. The halos are of the order of 25 μm in diameter and very extensive in their distribution.

Figure 9 gives a comparison of the effects of different radiations. The three polonium isotope effects are shown and the result from the uranium-238 decay system. The uranium decays through a series of changes generating these three isotopes (and other elements).

One strange effect, which is of interest to us, is that some halos contain the effect of polonium but no indication of the parent uranium. A number of mechanisms for this effect have been suggested, but they are not of practical significance. Gentry, however, proposed that very rapid crystallization could have occurred, simultaneous with the creation of polonium. The polonium would disappear without trace in less than twenty years. There were also features of *much greater decay rates*. This would be consistent with the model proposed above for dating processes.

There are some problems with Gentry's work. The geological context of the halos suggests that not all the rocks that he describes are Precambrian and nor are they all in granite. A range of other rocks are reported: pegmatites, calcite and fluorite vein dikes, gneiss. Several of the rocks are also more likely to be Phanerozoic (*i.e.* post-Precambrian) and, for the creationist, post-Creation. Further, there is some dispute as to whether these halos were all created *in situ* (Brown *et al.*, 1988; Wise, 1989).

Gentry also examined the halos in coalified woods. These are often deformed from circles into ellipses. This would be due to the processes of compression and solidification. But of further interest is the ratio of uranium-238 to lead-206 in the wood. Since these coals occur between the Cretaceous and Triassic periods, this ratio should be low, that is, a substantial proportion of the uranium should have decayed into lead. In fact, they are high; less decay has occurred than would be expected on the conventional timescale. The values are up to ten thousand times too high. So, the rocks may represent timescales of millennia rather than hundreds of millions of years.

Fission Tracks

A further potential source of dating information comes from the fission tracks found in uranium-based minerals. Uranium-238 undergoes spontaneous fission and releases charged particles. Because of the high energy of these particles, when they travel through a solid they leave a trail of damage, about 10 μm in length. The tracks can be detected by etching and examination under an electron microscope (Faure, 1986). These tracks fade when they are reheated, so their density can be used to estimate either the age of the rock or, if it has undergone some thermal treatment, its history.

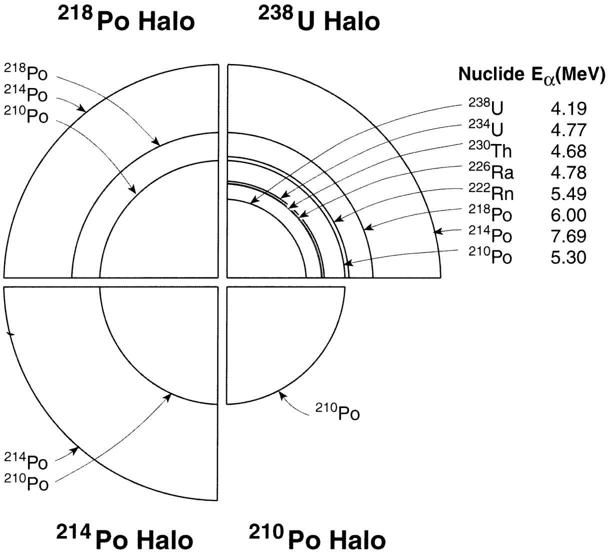


Figure 9: Structure of Radiohalos

Clearly, because of the high concentration of tracks, one must conclude that there has been a lot of activity in the past. This is used in support of the old-age interpretation of the earth. Some, as indicated above, would consider the creation of the earth to have been billions of years ago with the creation of life being more recent. In this scenario they would agree that the fossilisation occurred during the Flood and the fission tracks are inherited by young rocks from older ones. Certainly fission tracks can be inherited, but it must remain a matter of speculation as to whether this would adequately explain all the data. Alternatively, there is the possibility that there was a period of more intense radioactivity in the past.

In isolation, the fission tracks can reasonably be used to support a belief in an old earth. When the rest of the evidence is taken into account, it does seem that a higher rate of decay in the past is a likely explanation. We need to find a means of testing this scientifically.

Conclusion

In this paper, we have sought to show that biblical history is consistent with geological history when rightly understood. We have looked at the radiometric dating methods to determine how reliable they are. There are substantial causes for concern. We have sought to demonstrate that much of the data can be readily reinterpreted within the proposed biblical model.[8]

Kazmann (1978) reported on a symposium in which the astronomer John A. Eddy said, '… I suspect that we could live with Bishop Ussher's value for the age of the Earth and Sun. I don't think we have much in the way of observational evidence in astronomy to conflict with that.' He believed that it is palæontology that determines solar chronology. But what does palæontology really require?

Continued on Page 24

A Spanish Weekend

Michael Garton

A HOLIDAY? It was before dawn. Everyone chattered good humouredly as they ate breakfast in a hotel (Figure 1). But I felt uneasy as a conversation I had had with Steven Robinson months earlier floated into my mind: 'Here is a letter we could send to invite people to come,' I had said. He read the letter and replied, 'You can't say "a weekend's field*work*". People wouldn't come—call it a Spanish field excursion'. So, 'excursion' it became.

Figure 1: Breakfast at the Hotel Virrey.

(Left to Right: Nancy Darrall, Sean McCormack, Richard Johnston, Geoff Lewis, Joan Rosevear, John Peet, David Rosevear, Michael Garton, Jim Wiltshire.)

What was the 'excursion' for? Among creationists there is little consensus about geology, even over the evidence, let alone how to explain it. We wanted to address the main problem areas in creationist geology and Spain was a good place to come. It has a full geological history and most of the issues could be faced there. If you pick a region with sufficiently limited geology, you can 'prove' almost anything—but you cannot do that in Spain.

And now here I was, in Spain in October 1996, having filled two minibuses, not just for one weekend, but two. Would this now happy crowd cope when they discovered just how much was to be fitted into today's so-called 'excursion'? Would they rebel?

First of all it's a long drive; hotels, indeed human settlements, are few and far between in Rioja. There will be rocks from almost all of the 'geological column' to see, but will they get confused by seeing so many types one after another, and all in a rush? They will see colossal movements of continental crust—geologists call it *overthrusting*—which occurred during Alpine mountain building. They will have no problem remembering that: it's too awesome—like a breaking wave made of rock. That takes us up to lunch! All that novelty is probably enough for one day—maybe we *should* have made it a week's trip.

Then the tricky bit. They will have to use all their powers of imagination as they get to work and 'undo' the Alpine squashing, only to discover that an earlier phase of continental crushing must have already happened. This will take miles of driving and several stops to make sense of. Will they get hopelessly confused? The geology is at least undergraduate level, and many of them have never done any fieldwork—er, sorry—have never been on a geology excursion. Still, everyone on the trip is intelligent—and interested in what I want to show them; maybe it will be OK.

That's fine if they all agree that the rocks do show this is what happened. Suppose they do not: some of the party have come on the trip suspecting that overthrusting is imaginary, a devious plot by evolutionists to rescue the geological column. Isn't *everything* about the geological column a pariah to young-earth creationists?

So what about terminology? If I use the geological names from the geological column (*e.g.* Cambrian, Jurassic, *etc.*), will I be accused of assuming a certain answer? The Rioja strata labelled as 'Jurassic' on the geological maps is dominated by an impressive white limestone. I could say 'impressive white limestone' every time, but that's an awful mouthful. I will ask them if I can use 'Jurassic' just as a description, a code for the longer one, and similarly for the other distinctive layers.

The Journey

We set off immediately after breakfast, with the sun just rising over the mountains. The journey took us through the huge and flat Ebro basin, past mile after mile of red sandy soil growing olives and almonds, and grapes for the famous Rioja wine. This sandstone deposit is several kilometres deep, and we stopped at a cliff to examine how the fine sand had been laid down by water. This material had washed off the mountains we were going to see.

From there, the roads got narrower and bumpier. The party really started to wonder what they were in for when we turned off onto a gravel track which wound steeply up the side of a mountain.

Moving Mountains

Scripture says the surface of the earth can be 'distorted' as a judgment on human sin (Isaiah 24:1), and mountains can 'skip like rams' (Psalm 114:6). Mountains might even 'be carried into the heart of the sea' (Psalm 46:2). It is easy to dismiss such passages as poetic imagery—the Hebrews had such vivid imaginations.

It seems inconceivable that mountains might do any of these things—they are so solid and immovable—such a symbol of permanence. But when you look at some—when you go to the Sierra de Cameros, where we went, you find that the mountains did them all!

—The layers of rock on Cerro Penalba are distorted into a spectacular Z shape, visible from miles away on a clear day (Figure 4).

—The Sierra de Cameros mountain range was formed by overthrusting, by being pushed up over the adjacent land, just as a ram mounts a ewe.

—Erosion carried high mountains—far higher than the present ones—into what was then sea.

When you see the evidence, and become convinced that overthrusting is awesomely real, you feel small. You are overwhelmed by the sheer scale of the enormous power which God displayed. What a witness to God's awesome power in the earth's history! How sad and misguided when creationists deny it!

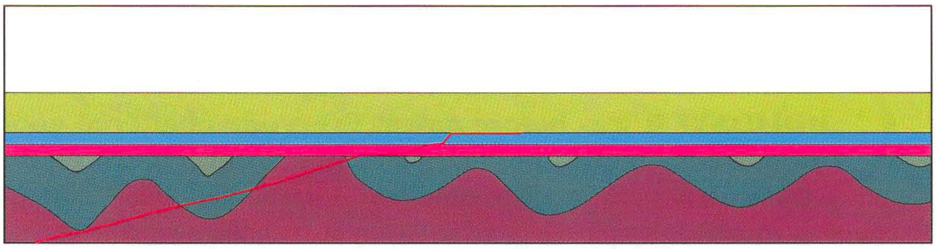


Figure 2a. As Spain was squeezed between Africa and Europe, a fracture developed in the continental crust and penetrated upwards into the latest sedimentary layers that had been deposited (Cretaceous). This was the beginning of Alpine Overthrusting.

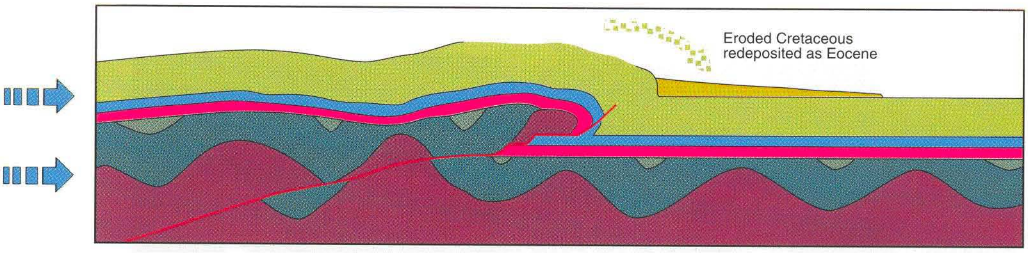


Figure 2b. The continental crust on the upper side of the break began to move to the right (north). Like a carpet, the front edge of the overthrusted block folded over as it moved. The mountains which resulted were readily eroded. Much of the Cretaceous is fairly soft silt and mudstone: fine material which was redeposited as early Tertiary sediments of the Ebro Basin.

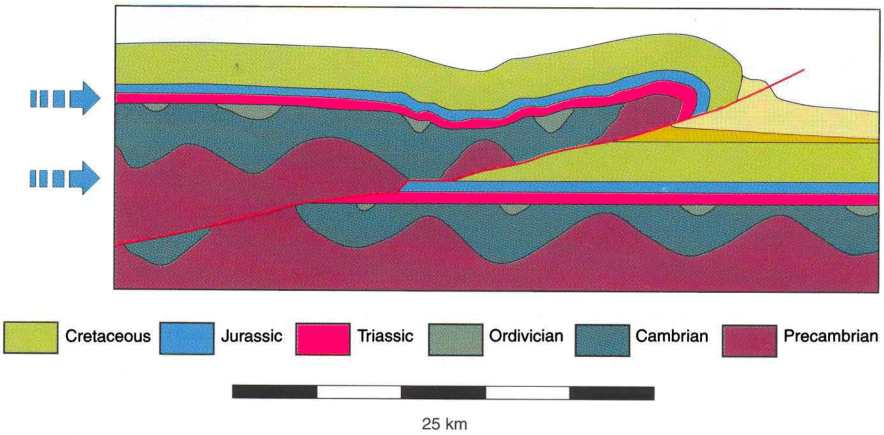


Figure 2c. As the upper block moved and folded, mountains formed, which were rapidly eroded. However, to illustrate the structure, this section does not show any erosion, although during the Eocene most of the relatively soft Cretaceous strata would have been stripped off the upper block, leaving the tougher Jurassic limestones exposed. As overthrusting continued the Jurassic was eroded and redeposited as Oligocene conglomerate. Removal of the Jurassic exposed Triassic sandstones so they too start to appear in the conglomerate. Eventually, the uppermost conglomerate debris contains the Palæozoic also. Notice how the thrust overrides these Tertiary sediments shed from the mountains.

What is Overthrusting?

So what is overthrusting? The huge scale of the thing makes it hard to imagine. We need familiar images as illustrations.

Suppose we take a stiff rug, cut it in two, and push one piece over the other. Initially we'll get two layers of rug one on top of the other. Then suppose that the front edge of the top rug catches in the pile of the lower rug: as pushing continues, the top rug then arches up and folds over in a loop, which lands on the lower rug beyond where the top rug caught in the pile. This is what we saw in Spain—not in a rug, but in rock—on a continental scale (see Figure 2). The rug is the earth's crust, the cut is the initial continental fracture in the crust. The fracture and overthrust were caused by Spain being squeezed between Africa and Europe.

The rug analogy is a simple picture. For more detail about what happens to the various rock layers, we will take one of those elaborate gateaux which has several layers, each of a different sort of sponge or marzipan with layers of jam, cream or icing in between. To represent the initial fracture, instead of cutting the cake straight down as you would normally do, we'll cut it at an angle of about 30 degrees to the horizontal. If we push the two parts of the cake together, the part of the cake above the cut slides up and over the cake below. The cake gets taller, and narrower. As we do this, some of the layers in the upper cake dig into the layers of the lower cake, damaging the boundary. Sometimes one of the layers sticks on one of the lower layers and the layers in the upper part of the cake start to distort into curves and may fold over like the rug. Unlike a rug, sponge layers won't stretch much without breaking, and crack on their convex edges, generating crumbs. The cake is now tall and narrow, some of the sponge has broken up into crumbs, which have fallen off, or got mixed up with the softer jam and cream. However it is still possible to look at all the pieces and decide from which layers they came. Some layers which were once below other layers are now found above them.

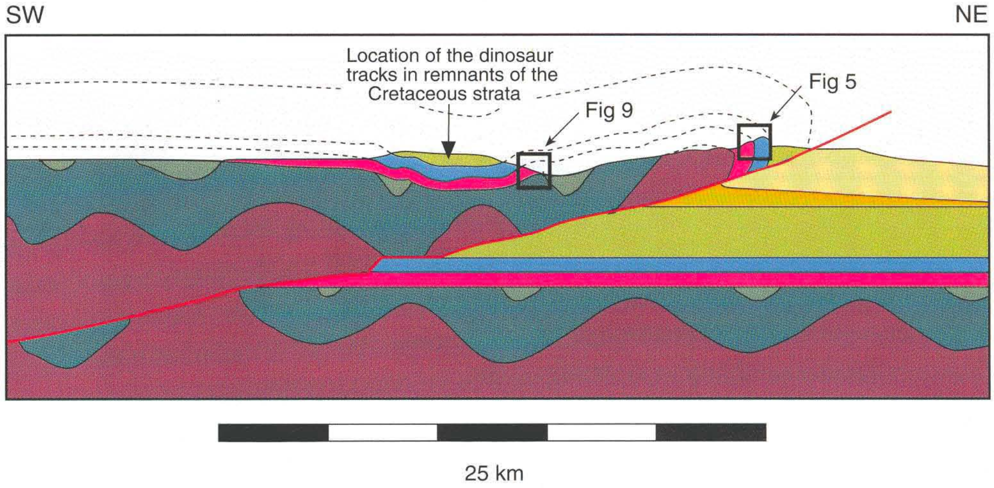

SW
NE
Location of the dinosaur tracks in remnants of the Cretaceous strata
Fig 9
Fig 5
25 km

Figure 3: Cross-section through the thrust today. Much of the overthrusted block has been eroded away and redeposited as Tertiary strata (Oligocene and Eocene on the right). Part of this structure was photographed for Figures 5 and 9. Section includes data from Instituto Geologico y Minero De España (1960) and Jurado and Riba (1996).

In Rioja, as with mountain building elsewhere, crustal overriding generates high mountains. Like sponge cake, rocks crack easily when stretched and the small pieces produced erode quickly. They fall off the convex front of the thrust as it tucks under, just like water falls from the front of a breaking wave on a beach. The advancing overthrust rides over the top of these loosened boulders and cobbles, which fall off or are washed down from these new mountains even as they are created.

As we travelled up the mountain track we found fragments of different sorts of rock set in sand (rather like concrete), what geologists call conglomerate. We took samples of the boulders and found we could match them to identical rock in the overthrusted block. The sand was of the same texture as that in the softer layers of the overthrust block. We all agreed there was no doubt where the boulders had come from, and their size and angularity indicated that both erosion and redeposition had happened quickly.

There was a great deal of this conglomerate material, forming a spectacular landscape of huge red cliffs. It was obvious that a large proportion of the upper, thrusted sheet has been removed by erosion. The part which remains today is shown in Figure 3.

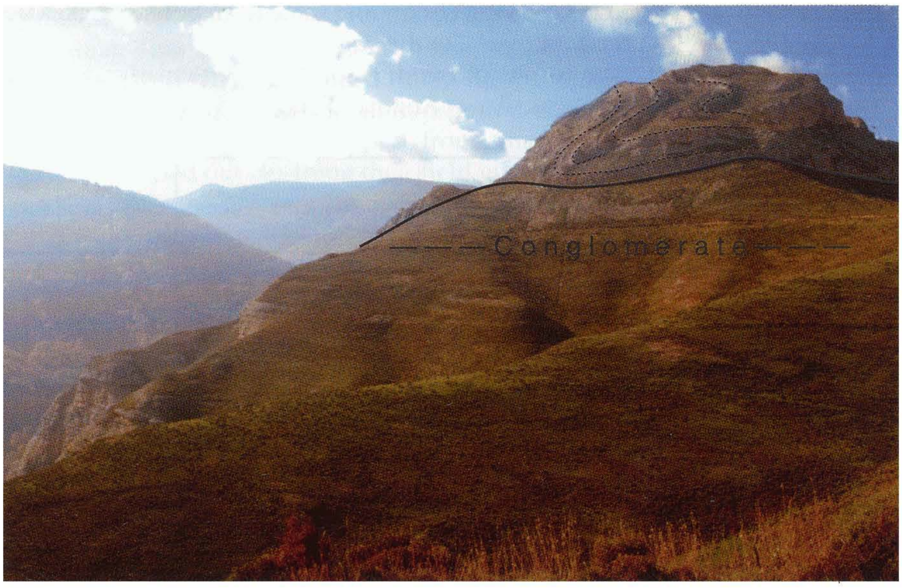


Figure 4. Strongly folded Jurassic limestone thrust over horizontal Tertiary (Oligocene) conglomerate. The conglomerate contains boulders derived from the limestone. Cerro Penalba, part of the Sierra de Cameros mountain range, Rioja.

Are you Really Sure it's Overthrusting?

Is overthrusting the only plausible explanation? These reasons made us certain:—

1. The rocks making up the mountain above the thrust plane were intensely folded (see Figure 4). Something violent *had happened!*
2. We found the boundary—the *contact*—between the rocks which had been moved and the rocks below them. The rocks were pulverised and ground up, and we found marks that look like polished grooves—called *slickensides*—where rocks had slid over one

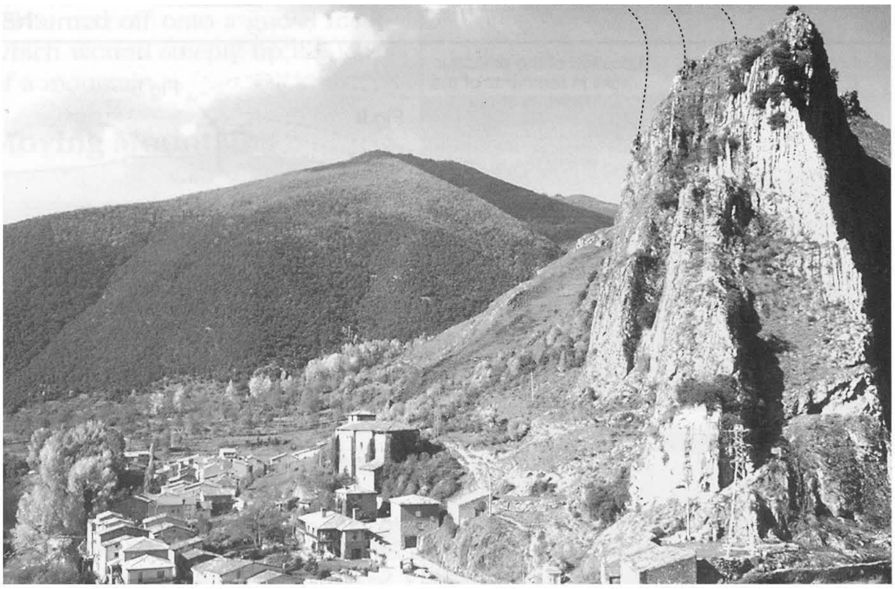


Figure 5. Formerly horizontal Jurassic limestone now standing vertical in the front part of the Alpine fold (see Figure 3 for the regional context). Anguiano, Rioja.

another. Near the contact some rock layers were very jumbled in direction—like the twisted bodywork of a car after a bad crash.

3. This contact between the upper block and the conglomerate below also shows up on geophysical surveys as a discontinuity going deep into the crust. So the junction we saw at the surface, whatever its nature, reaches down to great depths.
4. Finally there is evidence from a number of oil wells. This shows that the rocks which are in the upper unit are repeated, in the same order, at depth. Hence the upper block has overridden the other.

How Far did the Rocks Move?

How far did the overthrusting crustal block move? The answer is amazing: if you restore everything back to the starting position, the reconstruction demands over 20 kilometres (over 13 miles) of movement! This is a simple geometrical necessity.

How can the Rocks Move so Far?

We found mangled and pulverised rock at the contact in some places near the leading edge of the overthrust. But in other places on this mountain the contact shows little sign of the colossal movement that occurred. I have often seen the same apparent lack of evidence for movement along thrust planes in Europe and North America—but only when examined on a local scale. Invariably, the regional evidence is as unequivocal as it is here.

This tells us something important. We saw rocks which had cracked, and the cracks had filled with the white chalk-like mineral called calcite. The calcite had 'annular' rings like a furred up hot water pipe, suggesting that the deposit was laid down by hot water passing through the crack under pressure. Movement of these crustal blocks was possible because the rock was jacked up by water under enormous pressure. They moved relatively easily provided they moved quickly, before the high pressure water escaped through the cracks created by the overthrust movement itself. When the water pressure subsided, the overthrusted rocks settled gently on top of the rocks below. The hot, escaping water contributed to the erosion of the mountains even while they were being built.

Loss of water pressure would have been most likely at the front of the overthrust along the line of the contact and through the overthrusted rocks, which are at their thinnest there. Because of the increased friction, the rocks there then jam and the continuing force from behind makes the rocks fold over like the rug.

The results of overthrusting are particularly awesome and spectacular at Anguiano (Figure 5). Everyone on the

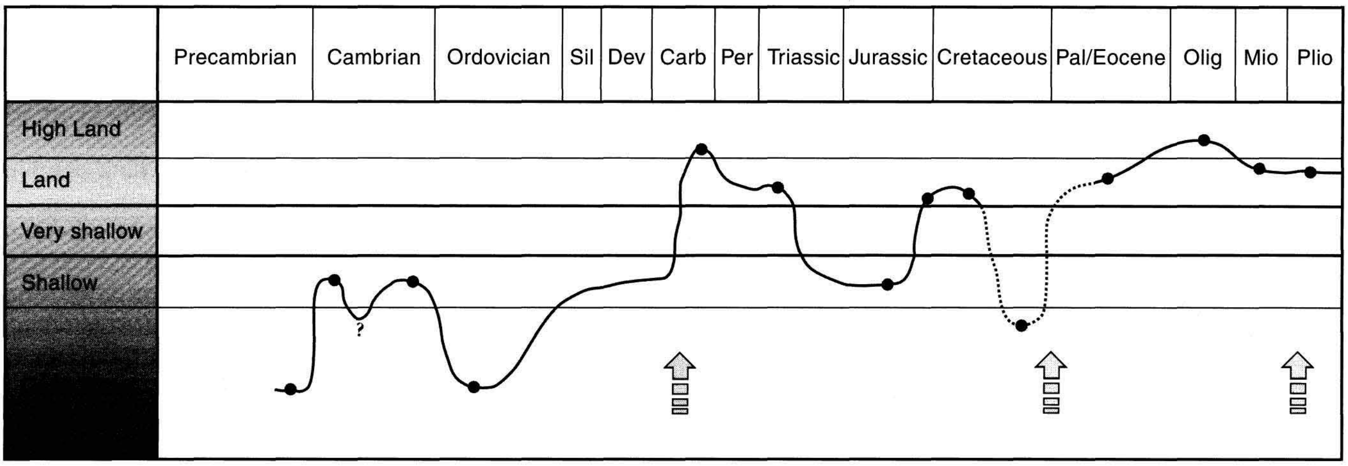


Figure 6: From our fieldwork, we concluded that we could make estimates of ancient sea-levels. Our work agrees reasonably well with published estimates for the whole of Spain and the world. The arrows indicate the three suggested Flood endings.

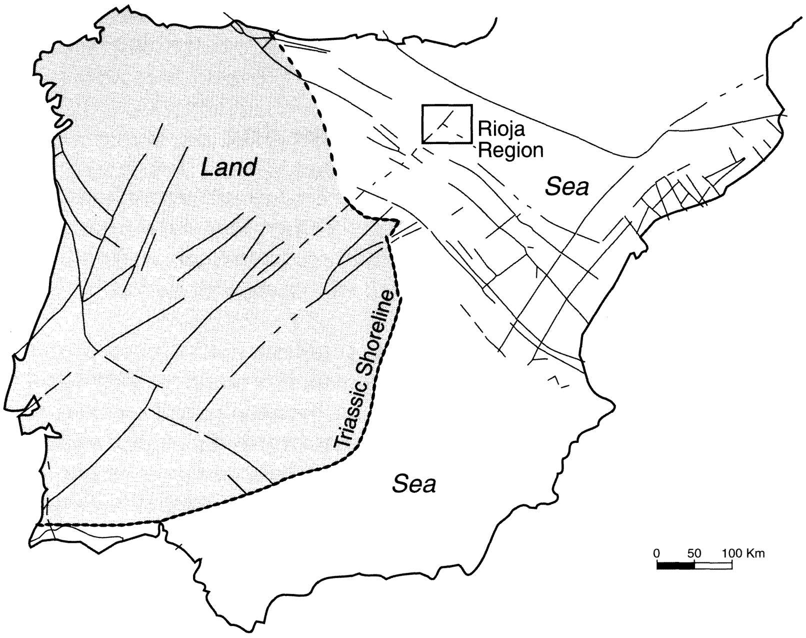


Figure 7. Ever since the time that upper Carboniferous strata were deposited, western Iberia appears to have been above sea-level. The diagram shows the approximate shoreline for Triassic times, but this did not change significantly until the Tertiary, when the seas retreated towards the present day margins. The fine lines show known Triassic faulting, which is typically associated with Triassic strata over much of the earth. After Comba (1983b, p.48).

Spanish excursion was convinced that overthrusting should feature large in creation apologetics!

It was now time for the huge packed lunches provided by the hotel.

How Deep Was the Water?

Having completed our examination of the Alpine overthrust, we now had to work out what happened before that. This was the main business of the afternoon, as we drove through a steep-sided valley, through miles of rock strata in the upper block, all transported during the Alpine overthrusting. We stopped from time to time. Everyone jumped out clutching their field guides, studied the rocks, answered the questions and filled in the graphs which we needed to complete. Certainly a disciplined set of holiday-makers!

On each occasion, we tried to discover the probable depth of water when the strata were deposited, in order to complete the graph depicting ancient sea-levels. This is less speculative than might be supposed. For example, desiccation cracks, where the mud had dried out and cracked before hardening to rock, suggest that the mud had been exposed to the air shortly after it was laid down. Such strata cannot have been deep in the sea.

We started work in the lowest Cambrian strata: pure white sandstones, now much hardened by a squashing episode prior to the Alpine overthrust. Evidence of strong current activity suggested deposition in relatively shallow water. A similar white sandstone is found in the same position from the Arctic to the Antarctic. What was going on all across the world at that time to leave this vast blanket of sediment? I have studied these same Lower Cambrian rocks in Scotland for several years and have good evidence that they accumulated in less than a week. If we believe the testimony of a global Flood, sedimentation on this scale and speed is *exactly* what we would expect.

As the character of the Flood changed through time (Genesis 7:11,17,24; 8:1,3), we would expect the changing conditions to be expressed in the type of rocks forming at the time. We might expect each short-lived but world-wide condition to generate distinct sediments across vast swathes of the globe simultaneously. The lower Cambrian sandstones are one example. There are other distinct and widespread sediments later in the Cambrian, in the Ordovician and so on. The popular creationist suggestion that the Cambrian in one place is the same age as say the Silurian, Carboniferous *(etc., etc.)* somewhere else runs counter to these expectations.

No one found it too hard to make an estimate of the sea-level at the time of deposition at each location. Our jointly agreed results, charted in Figure 6, closely agreed with the published generalised estimates for Spain as a whole. This gave us confidence in the honesty of the published sea-level data for Spain.

Most, if not all, of Iberia was underwater when the Precambrian strata were deposited (Comba, 1983a, p.116). Cambrian strata testify to shallower seas whereas Ordovician deposits suggest deeper water and near total flooding of Iberia (Comba, 1983a, p.617). Whilst we did not focus on the Precambrian, we did observe that conditions during the Ordovician phase were extremely violent. It seemed reasonable to ascribe Precambrian to Ordovician strata to the Flood.

The same is not true of the Carboniferous period onwards: for much of the time the Rioja area was above water, partially returning to marine influence during the Cretaceous before reverting to a terrestrial environment in the Tertiary.

Indeed, after the Hercynian mountain building episode, during the Carboniferous, central and western Spain does not appear to have been flooded ever again (Figure 7). Birds, if nothing else, could have survived there continuously until now. But Scripture is emphatic that there was a time when the whole world was under water (Genesis 7:19–20) and does not record the re-emergence of the land until the end of 150 days (Genesis 8:3). We concluded, therefore, that in Rioja the end of the global Flood must have taken place around or before the time of the Hercynian mountain building. The time of universal destruction must be well before the Carboniferous period and all later land animal and bird tracks must be post-Flood.

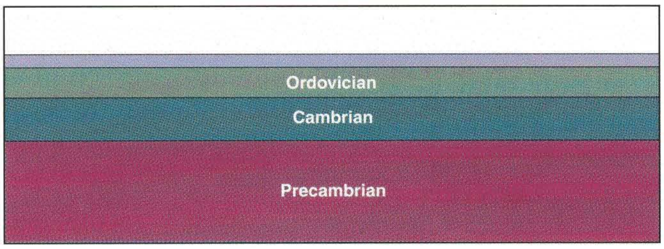


Figure 8a: Precambrian to Carboniferous Sedimentation

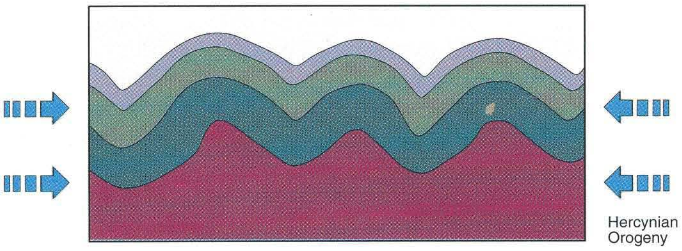
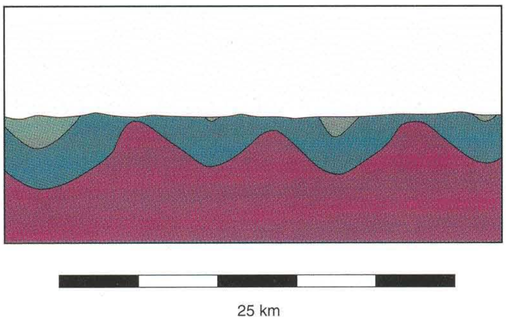


Figure 8b: Late Carboniferous Mountain Building



The pattern of sea-level changes in Rioja being similar across the world, I quoted the admirable summary of the global picture provided by Professor Van Andel (1994, pp.178–184):—

> 'Regarding the early Palaeozoic … we find it a wet world, its continents inundated far more than they have ever been since then, and the rise of the sea continuing. Before this rise ended, very little land remained above water.' This definitely sounds like a global Flood!
>
> [Concerning the sea levels leading up to Triassic times] '… a long slow regression that ended near the start of the Mesozoic with one of the lowest stands of the sea ever.' This is reminiscent of 'Behold the earth was dry' (Genesis 8:14)!
>
> 'During the Cretaceous, the inundation of the continents reached an extent not seen since the early Palaeozoic, and in the end little more than half of the present land area remained above the waves.'

While this may not have been a stable environment for Noah and his descendants, it was nothing like total immersion.

A Big Episode of Squeezing

The other drawing exercise during our four hour drive was Figure 2a, considered earlier. This shows that, when the effects of Alpine folding have been removed, the lower (older) strata are still crumpled, folded by some earlier episode.

Scale is a very real problem in deciphering earth history: we are just too small. It is therefore easy to miss the obvious. The twisting mountain road weaved and wiggled, backwards and forwards through the strata, which seemed to alter in direction quite arbitrarily. Without stopping every few miles to check the compass bearing—easier when the sun shone on the second trip—and sketch carefully the inclination of the strata, we would never have realised there had been this earlier folding. By means of this work, it became clear as time went on that for miles we were driving through layers all inclined in one direction—southward. Eventually we reached the centre of the fold, and then for miles further the strata dipped in the opposite, northerly, direction.

It was now simple, by the roadside, to join all the lines up. Everyone sketched the enormously long fold made by a phase of squashing (Figure 8b). This had to pre-date the Alpine overthrust we had seen earlier because this fold had moved bodily as part of the overthrusting block.

The drawings done, we walked a short distance up a hill to see what had happened to these earlier folds. The tops of the folds we had just proved (Figure 8b) had all gone (Figure 8c)—a vast amount of erosion had taken

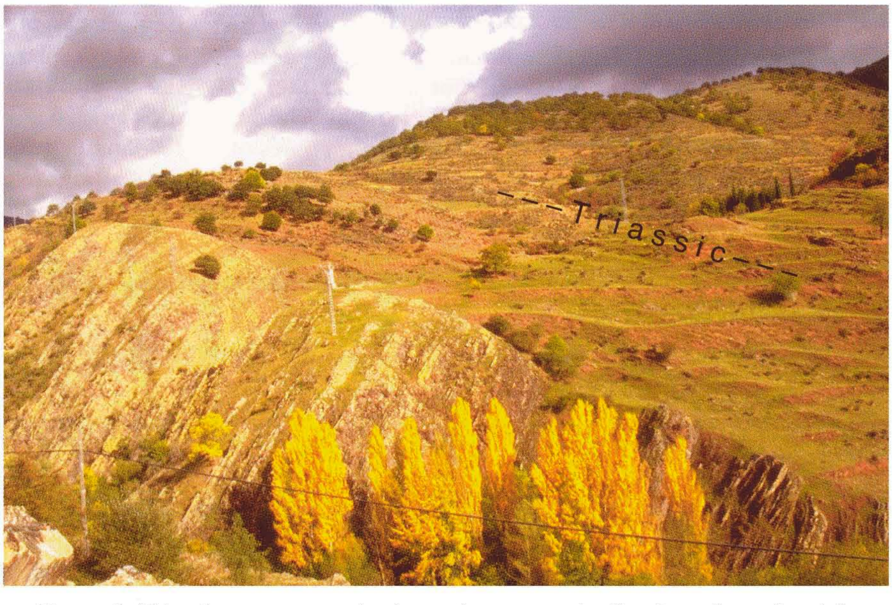


Figure 9: Triassic strata, once horizontal, are now inclined gently to the right (south), a result of being carried along during Alpine overthrusting. The Triassic overlies steeply deeping Cambrian beds. A discordant junction like this is called an unconformity. The Cambrian was folded in an earlier episode of mountain building, before the Triassic strata existed. Figure 3 shows this locality in regional context. Viniegra de Abajo, Rioja.

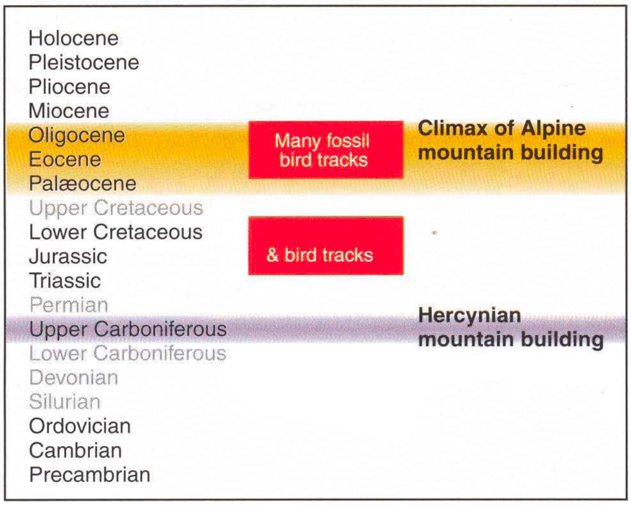


Figure 10: The local geological column of Rioja is subdivided by two episodes of mountain building. In a weekend excursion we saw strata correlated with all parts of the column except those shown in grey.

away kilometres of rock! Before us was the remnant of these great folds. After this massive planing process, they had been covered, first by horizontal red sandstone (Figure 2a and Figure 9), then by limestones containing ammonites, and above them by sediments replete with mud-cracks and dinosaur tracks. Much of these later sediments had been subsequently eroded. They were already familiar. They were the same layers we had seen earlier in the day at Anguiano, caught up in the big Alpine fold, and buckled so that the once-horizontal rock layers were vertical.

We now had enough information to start making sense of it all, so we sat down on the mountainside for a discussion. The view in front of us is shown as Figure 9.

The Geological Column: the Oldest *is* at the Bottom

We had established a real sequence in the Rioja area. The Precambrian was the oldest, then Cambrian, Ordovician *etc*., all the way to the Holocene. Two episodes of folding and mountain building (Figure 10) provide important time-markers:—

1. The earlier mountain building, called Hercynian Mountain Building, can be traced across eastern North America and through Europe. The sea-level evidence already considered suggests this episode roughly marks the end of the Flood.
2. The later episode is called 'Alpine' (or Alpine-Himalayan) because it can be traced continuously from Spain through the Alps and beyond. Alpine folding is always later than the Hercynian episode, with an interval of sedimentation (with all the dinosaur tracks) separating the two.

During the Hercynian mountain-building episode all the strata then existing (Precambrian to Lower Carboniferous) were heated up and cooked, that is, *metamorphosed*. This gives the rock a very obvious and characteristic shiny appearance. In Spain, later layers (upper Carboniferous onwards) are *never* metamorphosed. These early, metamorphosed layers are found as pebbles in the upper Carboniferous and subsequent layers. We may confidently conclude that the sequence up to the Lower Carboniferous is older than all subsequent layers. We saw that these oldest layers are at the bottom of the pile of strata.

A similar analysis is possible using the Alpine mountain building. The Tertiary strata owe their origin to the formation and erosion of the Alpine mountains. During the morning we had seen pebbles and boulders in Tertiary conglomerate sediments (Oligocene) consisting of the pre-existing Cretaceous and earlier sediments and had collected samples. We matched these samples with their sources (white Jurassic limestone, red Triassic sandstone, *etc*.). We could even state the order in which the older rocks were exposed through erosion to provide the material for the Oligocene (Figure 11).

These mountain building events prove that, at least in Rioja, the major divisions of geological strata—Precambrian, Palaeozoic, Mesozoic and Tertiary—are distinct, are separated in time and appear in that order. There has been no appeal to fossil or radiometric dating evidence.

Grounds for a Refund?

I told the party we could have arrived at nearly identical conclusions, and saved a lot of money, by visiting a location 5 miles west of Exeter instead of travelling 1500 miles to Spain. The early phase of squashing across Devon and Cornwall is similar to what we were seeing. The rocks there also look as if they were squeezed from the north and south in some gigantic vice. There too, the folds were planed off and covered by a very similar red (Triassic) sandstone, which in turn is overlain by (Jurassic) limestones with ammonites. Not only do the mud-cracks and dinosaur

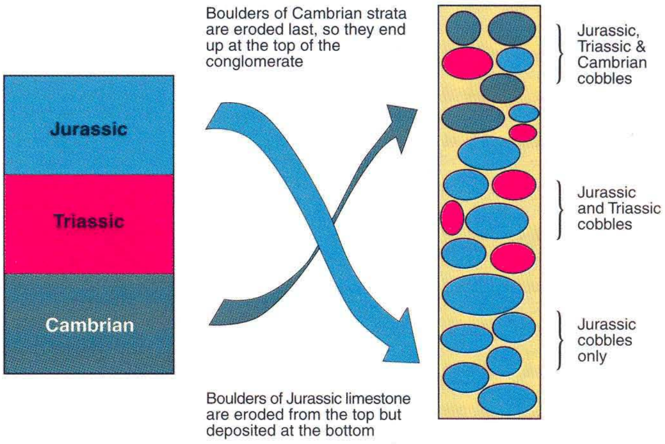

Boulders of Cambrian strata are eroded last, so they end up at the top of the conglomerate
Jurassic
Triassic
Cambrian
Jurassic, Triassic & Cambrian cobbles
Jurassic and Triassic cobbles
Jurassic cobbles only
Boulders of Jurassic limestone are eroded from the top but deposited at the bottom

Figure 11: The types of boulders in the Oligocene conglomerates changed up the sequence. By studying the proportion of the different types, we found we could work out which strata had become exposed to erosion for different levels in the conglomerate.

tracks (Cretaceous) then rest on top, as in Spain, but along the Dorset coast we could have seen all these strata squashed so that they became vertical and overthrusted during Tertiary (Alpine) movements!

At this stage I asked if anyone wanted a refund! The supposed advantage of going to Spain was good weather. Alas, on the first excursion, at first it rained and later became bitterly cold. At least, by going to Spain, they could see that there *were* parallels in the geological history of different regions.

Can Conclusions about the Geological Column in Rioja be Globalised?

These similarities between Spain and Britain raised a series of questions. Can we correlate the strata—were Cambrian strata in Britain and Spain formed at about the same time? Do these similarities extend more widely? Can we draw global conclusions about the geological column?

To try to answer these questions, I drew on my experience of reading about, and looking at, very similar structures throughout the world.

The episodes of mountain building were apparently caused by continental collision. Just as a ship coming sideways into berth normally hits the quay at one end before the other, continental collision in any one mountain belt will not have happened at *exactly* the same time everywhere. Nevertheless, being a single dynamic, continuous event, the squeezing at one end cannot be vastly separated in time from that at the other. Mountain building is accompanied by erosion and deposition, and its start and finish match with the corresponding deposits, providing clocks for each other. In the Hercynian case the time-scale is short, being associated with the upper Carboniferous and lowermost Permian strata.

Great thicknesses—tens of kilometres—of Flood sediment were caught up in the Hercynian event across the world. These needed time to form before they were folded. Therefore the Hercynian deformation cannot date from the earliest Flood (*c.f.* Figure 10). The earlier Carboniferous and the strata below already existed before Hercynian mountain building, not only in Spain, but in the Eastern States of the USA and throughout Europe.

The dinosaur-bearing layers were laid down in the interval before the Alpine mountains were thrust up. As in Spain, so also elsewhere in Europe and in the Eastern States of the USA, these layers rest on top of Hercynian folds. Red sandstones are characteristic, and all across the world the earth's crust was stretched and faulted (Figure 7) allowing areas of the crust to subside. Once again, these are seen in the USA and throughout Europe. This extensional phase, like the earlier compression, was a dynamic event affecting vast regions.

Even today, despite the local variations of climate according to latitude, the environments of the whole earth are closely inter-connected. Thus the weather throughout the world is affected by a single volcanic eruption. At the time in question, geological events took place on a world-wide scale. They must have caused great swings in the global environment, affecting the conditions under which the corresponding sediments were laid down. It is therefore not surprising that the sediments filling these faulted structures are similar everywhere. Nor should we be surprised that dinosaur tracks are also found above them, not only in Spain, but also in New England, in Britain and elsewhere.

Across the globe, deposition of the Tertiary strata is intimately bound up with Alpine-Himalayan tectonics, the second approximate time-marker. Just as we had determined on a local scale, the Tertiary sediments elsewhere are in sequence, lying above a full geological history inclusive of Cretaceous strata. Up to the Oligocene at least, the sediments contain the tracks of birds.

I concluded that approximate, relative dating of rock strata is indeed possible on a global scale. Combined with scriptural inferences, much more precise dating becomes possible—provided the geological model applied is correct!

Popular Creationist Misconceptions

We were still sitting on boulders on the mountainside; now we were defying the drizzle. Questions arose about some popular creationist misconceptions:—

1. *'Sideways sedimentation'* has been widely popularised as a way of discrediting the geological column. It is imagined that Carboniferous strata, for example, were laid down sideways at the same time as Cambrian strata. This mode of sedimentation can be demonstrated for individual ripples and layers in the laboratory. It also occurs within the layering of strata in the field—we found examples in the dune formations which formed the Triassic red sandstone. But to apply this principle to kilometres of sediment across whole continents is an enormous and unwarranted extrapolation of scale that is unsupported by field evidence. When we tested the concept in Rioja on the vast scale advocated, we found the concept invalid. Popularisation of this attempt to discredit the sequential order of the geological column brings justifiable contempt on creation apologetics.
2. *The Geological Column does not really exist,* since statistics have been published to show that around the world the components of the geological column are so incomplete that it can be disregarded. Such statistics are compiled from geological maps, but take no account of the geological history. The rocks present at any location are those which remain after many successive processes of deposition and erosion. At any one place some layers may never have been deposited (*e.g.* if the land was above water at the time), or have been subsequently eroded. Careful analysis across a region allows reconstruction of a geological history consistent with the geological column.

   The crude statistical approach is hopelessly misleading, as may be seen from its application to Rioja. From a map of the area, the first statistic recorded would be another mountain belt with rocks out of the expected order: the Cretaceous and Jurassic were apparently 'deposited' after Tertiary sediments. But such inversions *only* happen in mountain belts. We had seen this was the result of awesome overthrusting, and that far from discrediting the column it reinforces the concept!

A map could be used to 'show' the invalidity of the geological column. On Figure 3, exactly 50% of the area has only Precambrian, Cambrian or Ordovician present (as viewed from above, which is how such statistics are compiled). The geological column is then dismissed as irrelevant to Rioja. In reality our dynamic reconstruction of the geological history establishes how relevant the column really is! Even the missing Silurian to Lower Carboniferous may be found further north: these layers seem to have been removed when the Hercynian folds were eroded.

3. *Too Much Post-Flood Sediment?* I suggested that the boundary between the Flood and post-Flood deposits may well be located in the Carboniferous, so that the Hercynian mountain building may have continued after Noah stepped out of the Ark. This understanding implies a great deal of geological activity in the post-Flood period, which is startling to many people, and is claimed to be unacceptable on the grounds that it diminishes the scale of Noah's Flood. If the criticism can be substantiated anywhere, it can be in the Rioja region. The present deposits are as follows:—

Tertiary	<6km	Post Flood
Mesozoic	<7km	
Palaeozoic	6km	Flood
Precambrian	thickness unknown	

Published criticism (Holt, 1996) assumed that the Flood started at the base of the Cambrian, giving 13km of post-Flood sedimentation against 6km of Flood strata for Rioja—a clear case of Flood diminishers at work, one might think!

These criticisms are not what they seem. Firstly, we had established that many kilometres of Flood strata had been stripped off (Figure 8c) to be redeposited as Mesozoic strata. Secondly, we found that much of the Tertiary was itself Palaeozoic/Mesozoic strata eroded and redeposited during Alpine mountain building. Every transfer of material reduced the amount of Precambrian and Palaeozoic strata. More significantly, many creationists now agree that much if not all of the Precambrian was laid down in the Flood, adding enormous thicknesses to the Flood side of the equation. It seems probable that in Rioja most of the Mesozoic and Tertiary deposits were derived from Flood deposits. All this shows that the validity of arguments about thicknesses of strata, like the statistics concerning the geological column, need to be considered in the wider context of geological history.

The End of a Long Day

By now we had definitely had enough for one day. We were tired. We made the lengthy drive back to the hotel, taking us through more spectacular scenery in the Jurassic limestone, in which we looked for fossils. The group still managed commendable enthusiasm as they searched. Unfortunately failing light forced us to bring the day to an end! We arrived back at the hotel long after dark, more or less in time for dinner at 9 o'clock.

Dinosaur Tracks—it must be Sunday!

Sunday was less hectic, definitely more of a holiday. We spent time with the Lord by a babbling stream, with the sound of cattle and goats ringing their bells as accompaniment to our worship. The way the shepherd *led* the goats rather than driving them impressed us all.

We resumed our geological excursion by visiting the beautifully preserved fossil dinosaur tracks of Rioja. A journalist summed up our feelings last year when he wrote, 'They looked so fresh and well-defined that I had the unnerving feeling that, had we arrived five minutes earlier, we would have seen the dinosaur plodding past.'

Standing before them on a remote mountain, one's first reaction is wonder (Figure 12). Some footprints are enormous, far bigger than those of an elephant. Few people can resist putting their foot beside that of a dinosaur to try and match the animals' stride. How were their footprints so beautifully preserved? Today, apart from in quick-drying cement, track preservation is uncommon—what happened to your footprints last time you walked on a beach?

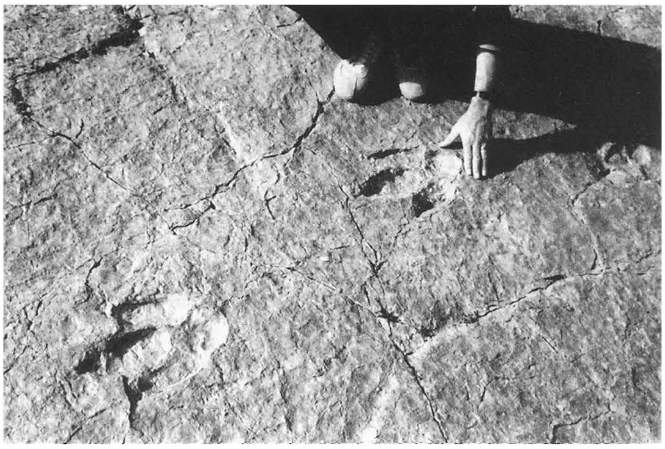


Figure 12: Footprints of a small carnivorous dinosaur. Munilla, Rioja. [Photograph by Andrew Blyth]

The World of the Dinosaurs

The dinosaurs lived in an environment totally unlike anything today. Whilst higher land certainly existed elsewhere, here dinosaurs walked over extraordinarily vast plains with no relief for hundreds of miles. They walked on soft ground, often in shallow water on delicately ripple-marked surfaces. Frequent incursions of sheets of water suggest these plains were close to sea level, but the delicate ripples rule out powerful currents. Had there been violent seas, such as characterised the early Flood (Genesis 7:11), they must certainly have engulfed the dinosaur-inhabited flats as easily as Holland today.

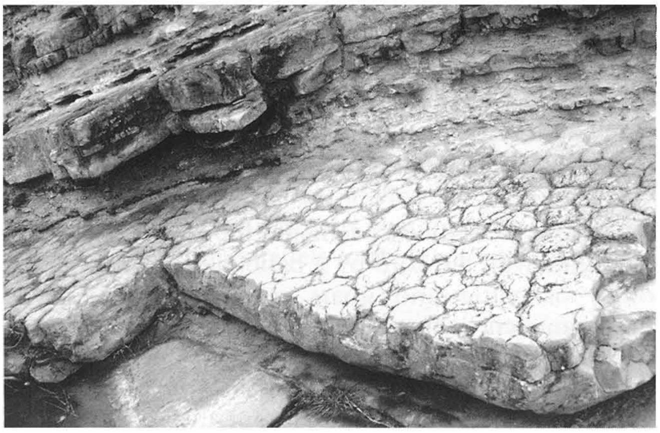


Figure 13: Mudcracks are extremely common in the lower Cretaceous of Rioja, sometimes associated with dinosaur tracks. They indicate hundreds of episodes when the vast mudflats dried out. Clearly shallow water conditions! Los Cayos, Rioja.

We found that mud-cracks (Figure 13) are extremely common, occurring at hundreds of separate levels. The surface must, therefore, have repeatedly dried out before being inundated by a further modest layer of sediment.

These extensive mud-flats formed a lonely world for the dinosaurs—their only vertebrate companions were birds. Bird tracks are associated with the dinosaur tracks in Spain as elsewhere. To judge from their tracks (Figure 14), no dinosaur appeared to be distressed or in a hurry—they are walking rather than running, and their tracks are orientated in all directions. They were not running to high ground in an attempt to escape the Floodwaters, although this is a popular creationist suggestion. Neither they, nor the sea, were in any hurry to go anywhere!

The party readily concluded that these layers did not fit with our expectations of a violent, early stage of the Flood. With so many dinosaur tracks, and, more especially, bird tracks, they must have been formed after the Flood.

The Special Significance of Bird Tracks

Scripture emphasises again and again that the Flood brought about 'the end of all flesh' (Genesis 6:13; 7:21). While great geological activity is reasonably inferred, the global destruction of life is what is particularly emphasised. God's judgment is sudden and certain—Luke 17:26–30 even seems to imply that all humanity outside the Ark died on the first day of the Flood. Certainly all land-dwelling, air-breathing creatures were destroyed during the initial violent stage of the Flood, within 40 days (Genesis 7:4,12,17–23).

Except just possibly in the early stages, Flood strata should lack any evidence that the creatures expressly singled out for destruction were alive. Wherever rock strata bearing fossil *tracks* of these animals are found, the animals which made them must have been alive. Any fossil tracks of these pre-Flood creatures would only be at the *bottom* of the Flood record and their numbers would *decline* as the Flood progressed and they succumbed to the waters. The more violent the Flood's beginning, the less likely the presence of any such tracks becomes.

Bird tracks are especially significant. Scripture is particularly emphatic that all birds perished in the early stage of the Flood (Genesis 6:7; 6:20; 7:3; 7:8; 7:14; 7:21; 7:23). In Spain, as elsewhere, bird and dinosaur tracks are often found together, although dinosaur impressions are much more common.

These tracks are an important guide to when the Flood ended and post-Flood strata begin; their position in the geological record is indicated on Figure 15.

Can we assume that some birds survived until near the end of the Flood year? We were unanimous that their late survival contradicted Scripture. Birds were blotted out, along with all that was to be destroyed with them, in less than 40 days. They were not present to make tracks again until they left the Ark to repopulate the earth. We would broadly expect bird tracks to *increase* through the post-Flood strata as their numbers grew.

Do Current Flood Models satisfy Scripture?

We were now in a position to assess the currently popular understanding of Flood geology, and see if it fitted in with what we had learned.

Currently popular Flood models place the end of the Flood in either the uppermost Cretaceous strata, just above the dinosaur and bird tracks, or uppermost Tertiary (Whitcomb and Morris, 1961), after practically all bird and air-breathing animal tracks. In other words, both models

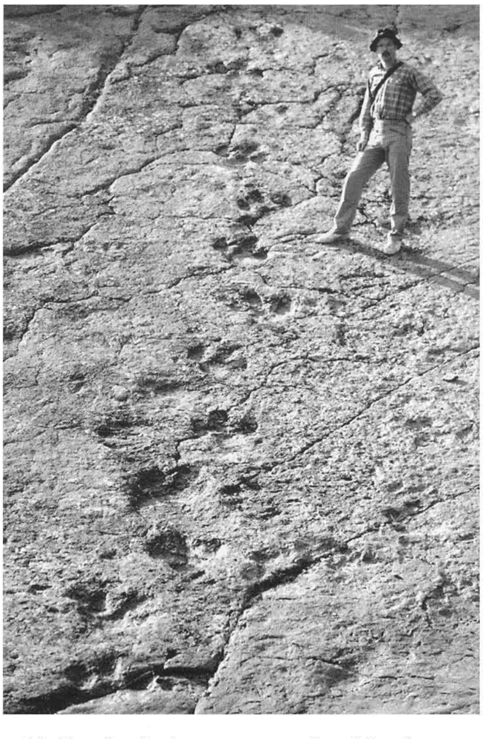


Figure 14: Track of a large Iguanadon-like dinosaur. We could tell that this dinosaur was moving both slowly and rather aimlessly because the track changes direction several times, the stride is small and the prints are angled inwards in a pigeon-toed fashion. Munilla, Rioja.

envisage pre-Flood birds surviving to make most of their tracks in strata formed well into the Flood year, even almost at the end of the Flood—the opposite of what we expect. But how did they manage to survive the early stages of the Flood?

It is a serious omission to leave aside Precambrian events with their full and violent geological history. I consider that the destruction of life took place during this interval (Robinson, 1996, pp.37–42), but we did not focus on this when in Spain. We did note how the trends in ancient sea-levels suggested continental flooding in the early Palæozoic. How did *any* birds and land-living animals survive Precambrian events and these still violent waters? Only if the flooding was very short-lived, contrary to the 150 days of Scripture (Genesis 7:24) and only if they were essentially tranquil, could birds and land-dwelling animals have survived. This objection applies especially to the Whitcomb and Morris model because a whole panoply of animal tracks of every kind are found in Tertiary strata. They survived the initial global flooding, yet *all* died, apparently without cause, at the close of the Tertiary. Whitcomb and Morris must be able to refute the geological column *in its entirety* for this to be plausible.

Turning to the end of the Flood, we have bird tracks in the lower Cretaceous: hence this and all older strata must be from the early Flood if it is true that the Flood ended in the Upper Cretaceous. The only strata laid down in all the rest of the Flood year would be the Upper Cretaceous (in England, just the chalk beds). There are no Upper Cretaceous strata in Rioja, presumably because Alpine mountain building had elevated the land. This elevation is a problem if the Flood ended with upper Cretaceous strata. Why did the birds and dinosaurs die? Presumably they *all* drowned—but *how?* As Van Andel makes clear in the quotation above, as far as we can tell, about half of the continents have always remained above the sea since the high sea-levels of the early Palaeozoic.

For the alternative model, the Flood typically ended with the deposition of the upper Tertiary strata (Whitcomb and Morris, 1961, p.283). There are many bird tracks in Tertiary strata to the east of Rioja, made at the height of the Alpine mountain building (Raaf, *et al.*, 1965). Practically all strata must be ascribed to the early Flood period and practically nothing assigned to the effects of the Flood after the initial 40 days, or to the period following the Flood. Floods are not like that—even today, the landscape requires time to recover after a major flood. A global Flood that destroyed all land-living life, deposited kilometres of sediment, yet had so little aftermath is unreasonable.

Certainly much of the geological record is characterised by fast deposition. But both of the above models suggest that more than 25 kilometres of sediment (probably much more, depending on the thickness of the Precambrian) were deposited, not in a year, but in just 40 days. Then almost nothing happened during the remainder of the year! The sedimentary strata we saw in Rioja were formed at rates which are not consistent with this. Moreover, both models envisage birds and land-living creatures surviving, against overwhelming odds, yet cannot explain why *all* of them should then die before the Flood ends.

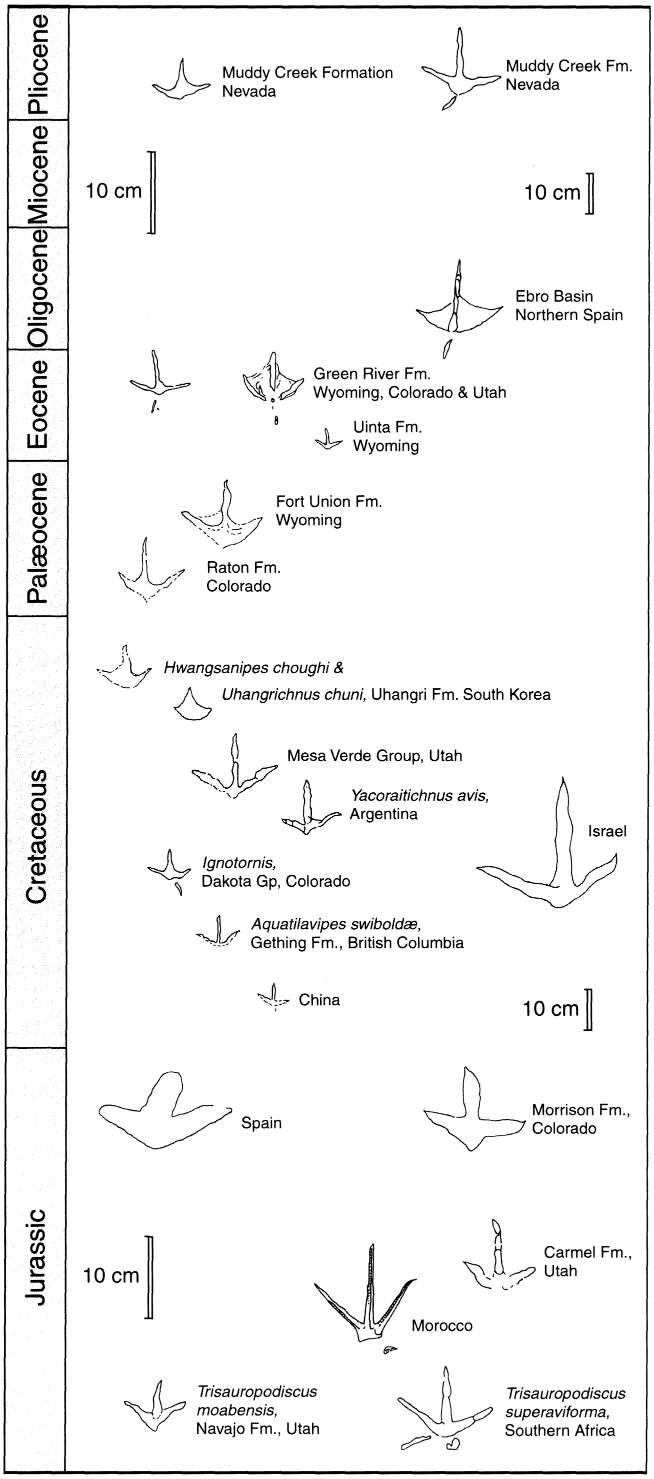

Pliocene
Miocene
Oligocene
Eocene
Palæocene
Cretaceous
Jurassic
Muddy Creek Formation Nevada
Muddy Creek Fm. Nevada
10 cm
10 cm
Ebro Basin Northern Spain
Green River Fm. Wyoming, Colorado & Utah
Uinta Fm. Wyoming
Fort Union Fm. Wyoming
Raton Fm. Colorado
Hwangsanipes choughi &
Uhangrichnus chuni, Uhangri Fm. South Korea
Mesa Verde Group, Utah
Yacoraitichnus avis, Argentina
Israel
Ignotornis, Dakota Gp, Colorado
Aquatilavipes swiboldæ, Gething Fm., British Columbia
China
10 cm
Spain
Morrison Fm., Colorado
Carmel Fm., Utah
10 cm
Morocco
Trisauropodiscus moabensis, Navajo Fm., Utah
Trisauropodiscus superaviforma, Southern Africa

Figure 15: Summary of the fossil bird track evidence being discovered on most continents. Prints on the right are drawn at half the scale of those on the left because they are much larger. From data in Lockley et al. *(1992), Lockley and Hunt (1995) and Yang* et al. *(1995).*

The presently popular models are, therefore, implausible. It is also necessary to reject several popular conjectures about geology which have been widely promoted in an attempt to bolster one or both of these models. Our work in Rioja showed that they too are false:—

1. *Conjecture:* Sedimentation proceeded sideways across continents.
   Intended purpose: Discredit geological column.
   Truth: This vast extrapolation of laboratory evidence is contradicted by field evidence.
   Result of error: Discredits creationist witness.
2. *Conjecture:* Overthrusting is a device by evolutionists to rescue the geological column where strata are not in the expected order.
   Intended purpose: Discredit geological column.
   Truth: Overthrusting is an awesome geological phenomenon bearing witness to an awesome God of great power. It does not contradict the geological column.
   Result of error: The recognition of sequential, global, patterns in strata is lost.
3. *Conjecture:* The fossils date the rocks but rocks date the fossils so relative geological dating is circular and false.
   Intended purpose: Discredit geological column.
   Truth: Rock sequences can be established locally, regionally and globally without reference to fossil or radiometric dating evidence.
   Result of error: Global patterns of similarity in different rocks are denied.
4. *Conjecture:* There are very few places on earth where the geological column is complete and therefore it is an artificial construct.
   Intended purpose: Discredit geological column.
   Truth: Analysis of the structure of a region leads to an understanding of its development over time which corroborates the geological column.
   Result of error: Global patterns are denied and the geological record is confusion.
5. *Conjecture:* There is too much Mesozoic and Tertiary sedimentation for all of it to be post-Flood in age.
   Intended purpose: Minimise post-Flood geological activity and allocate larger proportion of geological column strata to the Flood.
   Truth: Even with Flood deposits confined to the Palæozoic, the *originally deposited* Flood sediments are vastly greater in volume than the post-Flood deposits; the Mesozoic and Tertiary sediments are largely reworked Flood sediments.
   Result of error: By assuming the Mesozoic is Flood sediment, geological evidences that there is not enough time in the Flood year for its formation are ignored.
6. *Conjecture:* Creatures fled to high ground to escape the rising Flood water.
   Intended purpose: Account for the presence of land-living fossils in the geological record.
   Truth: There is a lack of field evidence of animals in panic or hurrying to high ground. When God acts in judgment, He acts fast and there is no escape.
   Result of error: In practice, the violence of the Flood is denied.
7. *Conjecture:* To depart from the Flood model advanced by Whitcomb and Morris is to detract from the testimony of Scripture.
   Intended purpose: Support biblical witness to the power of God in judgment geologically.
   Truth: The Whitcomb and Morris model not only fails to fit the facts, but requires a very tranquil Flood. The true witness of the Flood is that God acts swiftly in judgment, and that His judgments have on-going consequences.
   Result of error: By adopting a false model, creationist witness to the reality of the world-wide Flood is held in contempt.

The currently popular models require the multiplication of false and doubtful hypotheses. Much effort has been expended in unnecessary and counterproductive attempts to discredit the geological column. The problems raised by these models and their supporting conjectures, including problems not confronted in Spain, can all be avoided by using a better model.

Conclusions—Making Sense of Our Experience in Rioja

At the hotel we finished off by putting all we had seen into the context of the Biblical witness to a global Flood and its aftermath.

(a) The Geology

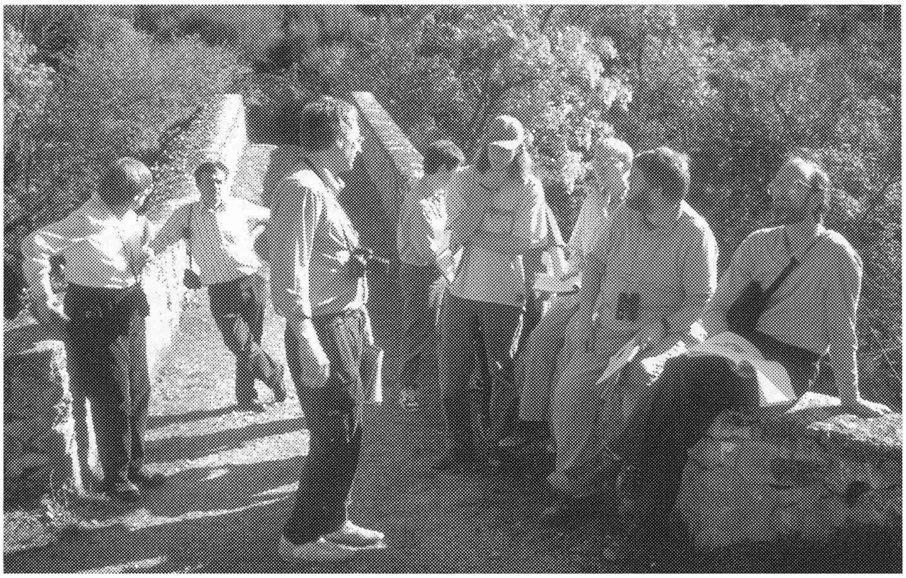
We had seen strata attributed to most parts of the geological column and established that the sequence in Rioja was real. The oldest layers in a thick sequence of strata are at the bottom, the youngest at the top, consistent with the geological column. Beginning with Precambrian strata, most units of the geological column are either still present or could be shown to have been there once but subsequently eroded away. Locally, each 'period' of the geological column has chronological significance but we saw no evidence incompatible with a young earth time-scale. (Acceptance of the order of the geological column does *not* imply acceptance of biological evolution or long evolutionary time-scales.)

Rioja's geological history was punctuated by two erosive episodes which correspond to periods of mountain building in the Carboniferous (Hercynian) and Tertiary (Alpine). The evidence for regional overthrusting in the Tertiary convinced everyone, including sceptics, that this is a real, rapid and awesome phenomenon.

By placing what we had observed in Spain in a much broader dynamic context, we could see that it was representative of geological events affecting other parts of the globe. Mountain belts are transcontinental and associated with particular parts of the geological column. The belts enable the Rioja strata to be correlated roughly across vast distances and encourage the belief that geological periods like the Carboniferous happened at much the same time everywhere.

A believer in the Flood should surely expect globally significant events to be expressed globally in the rock record. If, for example, the Cambrian was laid down about the same time across the world, the extremely widespread white sandstones of the lower Cambrian probably reflect one short-lived worldwide sedimentary event.

For Rioja, we estimated ancient sea-levels for most of the geological record from the character of the sediments they left behind. These agreed with published data for Spain as a whole and also compared favourably with global estimates. Such agreement further supports the view that divisons of the geological column (such as Ordovician) not only represent short periods of time, but that interval is contemporaneous across continents.



A Pause to Reflect.

(Left to Right: Wendy Sharpless, Clifford Denton, Michael Garton, Andrew Blyth, Jon Chambers, Paul Garner, Randall Hardy, David Tyler.)

(b) The Biblical Context

Scripture says that the whole earth was under the waters in the early stage of the Flood. When we look for corroboration in the geological literature, only the earlier rock record comes close to supporting global inundation. Once the whole earth was under water, none of the animals and birds consigned to destruction can have remained alive (unless an extraordinarily tranquil and short-lived Flood is envisaged). Their tracks should not be expected until post-Flood recolonisation.

First and foremost, the Flood was an event that led to the destruction of life within 40 days. Scripture is emphatic that this included all birds. The presence of bird (and dinosaur) tracks in Cretaceous strata and many bird tracks in the Oligocene of the region must be accounted for by any Flood model which purports to explain Rioja geology.

Could the tracks be from creatures which survived until near the end of the Flood? This seems to contradict Scripture. If strata containing the tracks are held to be Flood strata, they must originate in the first 40 days. Since the tracks are found in later strata, to encompass them within the Flood year is to conclude that almost the whole geological record accumulated in less than 40 days.

Remembering that many creationists now consider that much of the Precambrian to be Flood strata, more and more activity is being compressed into less and less time. There is no doubt that rates of processes in the Flood (including sedimentation and overthrusting) must have attained extreme magnitudes. But on the basis of both theory and field evidence, there comes a point where 'extreme' moves to 'beyond credibility'. Either the interpretation of Scripture, or the models imposed upon it, are wrong. We concluded the currently popular models were wrong.

(c) A Preferable Model

A preferable model, faithful to both Scripture and our present scientific knowledge, has the Flood (initially very violent) corresponding to the Precambrian to Carboniferous interval. Thereafter, more than half of the continental land surface was always above water. But the Flood had made the Earth geologically unstable and it needed time to settle down. Noah and his descendants therefore witnessed a great deal of post-Carboniferous geological activity in the centuries following the Flood. Supported rather than threatened by the geological column, this model lets us use most of the published geological data, but within a greatly speeded up time-frame.

Nevertheless, it is important to sound a word of caution. Many of us may feel confident in this model and its ability to stand the test of time, but we still need to remember that the geological model proposed remains only a scientific model. It may be wrong in its particulars, or even wrong altogether. Future work must develop and, as necessary, improve upon it, or even reject it, in the light of further data. We do not fear this—our faith rests in *God*, not in our scientific models, or even our understanding of Scripture.

Wrong understandings of geology have been greatly detrimental to apologetics and to biological science. For the latter, a whole new vista opens up. Biologists need encouragement to explore how the devastated planet was progressively recolonised and how successive populations fared in the unusual and unstable conditions.

Recently, scientists have largely led the way in developing creationist arguments. It is time for those gifted in theology to make their contribution. If we are correct to suggest that the Flood began with terrifying power and abruptness, and that considerable after-effects to the judgment continued for centuries, this has to affect our understanding of God, ouselves, the future and the way we live our lives now. Great instability taking place so recently in human history may not be a comfortable thought, especially in view of the frightening future predicted in the Gospels and Revelation.

A rainbow appeared in the sky as one of the field days came to an end, and we were reminded that God does not give promises that we do not need. Noah emerged from the Ark onto a world so unstable and geologically active that half the continental areas were later reflooded. At that time, without the promise of the rainbow, Noah and his descendants might have wondered if another total Flood was starting. That time will come, but the judgment will be by fire, not by water (2 Peter 3:7).

Time was fast running out. Rock samples were bundled into bags, some very heavy. No wonder the plane bumped along the runway uncertainly as we took off! Looking out from the plane, we looked across to the mountains we had visited. We saw them with new eyes, as we thought of their mighty testimony to the awesome power of God.

I reflected again on my thoughts at Saturday breakfast. I need not have worried. Everyone coped, and saw *for themselves* that what Steven and I had put to them was convincing. Yes, the trip was a great success—well worth it!

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THE AUTHOR

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The Bible and Chronology

Continued from Page 10

Notes

1. Robinson's timescale is described in a series of papers (1995, 1996b). He demonstrates that gaps in the post-Flood genealogies are possible Scripturally and necessary geologically. However, he emphasises that the time shift is, at the most, hundreds of years.
2. An alternative scenario is proposed by some of the American investigators. For example, Oard (1995) has drawn attention to the dinosaur remains in the Mesozoic and correlated this to the second part of the Flood year. This is, we believe, unlikely in view of the biblical record. See also the response to this by Garner *et al.* (1996).
3. The half-life of a radioactive element is the time taken for the activity of an isotope to reduce by 50%. Each isotope has its own characteristic value.
4. The Bible account (Genesis 3:14–19) shows that the judgment on the man, Adam, affected not only himself but his wife and the world. Paul emphasises the effect on the non-human world too (Romans 8:19–22). The earth was created perfect to provide a pleasant and harmonious environment for man. Consequently, when man sinned, the world became his enemy.
5. It is often overlooked by readers of the Bible that a sequence of events is described as the outcome of the Flood both during the Flood year (eruption of the fountains of the deep, encroachment of the waters onto the coastal regions, global submergence of the earth's surface, stabilization of the waters, wind deposits and the retreating and returning waters) and beyond (movement of the seas across the continental fringes, adjustment of the climate, continental rifting and the ice period).
6. This point is dealt with in more detail elsewhere (Queries and Comments, 1996).

7. This should not be confused with the 'gap theory' which envisaged this as a time in which the original creation was destroyed by Satan. The possibility mentioned here is a time gap between the creation of the physical system and its forming and filling in the rest of the chapter.
8. A number of questions have been asked and comments made about this series. I propose to respond to these in the next issue of *Origins*.

Appendices

1. Summary of Melvin Cook's Work on Carbon–14

The net rate of build-up of carbon-14

$$= R_{\text{formation}} - R_{\text{decay}}$$

i.e.

$$\underset{\substack{\text{the rate of}\\ \text{build-up of}\\ ^{14}\text{C}}}{\frac{dC}{dt}} = \underset{\substack{\text{constant rate}\\ \text{of formation}\\ \text{since amount}\\ \text{of nitrogen}\\ \text{is very large}}}{k_f} - \underset{\substack{\text{rate of decay is}\\ \text{proportional to}\\ \text{amount of } ^{14}\text{C}}}{k_d.C} \quad \ldots \text{ equation 2}$$

We can relate each term to the equilibrium amount of carbon-14 which is a constant (C_{eq}):

$$\frac{dC/C_{eq}}{dt} = k_f/C_{eq} - k_d.C/C_{eq} \quad \ldots \text{ equation 3}$$

At equilibrium, $dC/dt = 0$, so from equation 2,

$$0 = k_f - k_d.C_{eq}$$

$$\therefore \quad k_f = k_d.C_{eq}, \text{ or } k_d = k_f/C_{eq}$$

So, substituting this in equation 3,

$$\frac{d(C/C_{eq})}{dt} = k_d - k_d.C/C_{eq}$$
$$= k_d.(1 - C/C_{eq})$$

Hence,

$$\frac{d(C/C_{eq})}{(1 - C/C_{eq})} = \frac{dt}{k_d}$$

Integration gives

$$t = \frac{-\,ln\,(1 - C/C_{eq})}{k_d}$$

Since $k_d = 1{\cdot}2 \times 10^{-4}$ and the average reported value of $C/C_{eq} = 0{\cdot}72$,

$$t = -\ ln\ 0{\cdot}028/(1{\cdot}2 \times 10^{-4}) \approx 10{,}600 \text{ years}$$

i.e. the build-up of carbon-14 has taken only about 10,000 years.

2. Derivation of the Isochron Plot

$$\text{Present amount of } ^{87}\text{Sr} = \text{Original amount of } ^{87}\text{Sr} + \text{Radiogenic amount of } ^{87}\text{Sr}$$

i.e.

$$[^{87}\text{Sr}]_t = [^{87}\text{Sr}]_o + [^{87}\text{Sr}]^*_t \quad \ldots \text{ equation 4}$$

where the asterisk indicates radiogenic origin.

Since 1 atom of the parent isotope (^{87}Rb) produces 1 atom of the daughter (^{87}Sr),

$$\text{Initial amount of } ^{87}\text{Rb} = \text{Present amount of } ^{87}\text{Rb} + \text{Amount of radiogenic } ^{87}\text{Sr}$$

i.e.

$$[^{87}\text{Rb}]_o = [^{87}\text{Rb}]_t + [^{87}\text{Sr}]_t^* \quad \ldots \text{ equation 5}$$

But, from equation 1,

$$A_t = A_o.e^{-\lambda t} \text{ where } \lambda = 0{\cdot}693/t_{1/2}$$
$$A_o = A_t.e^{\lambda t}$$

Applying this to equation 5,

$$[^{87}\text{Sr}]_t^* = [^{87}\text{Rb}]_t\,.\,e^{\lambda t} - [^{87}\text{Rb}]_t$$
$$= [^{87}\text{Rb}]_t\,.\,(e^{\lambda t} - 1)$$

Substituting back in equation 4,

$$[^{87}\text{Sr}]_t = [^{87}\text{Sr}]_o - [^{87}\text{Rb}]_t\,.\,(e^{\lambda t} - 1)$$

The amounts of the isotopes are measured relative to the non-radiogenic and presumably constant amount of ^{87}Sr.

$$\frac{[^{87}\text{Sr}]_t}{[^{86}\text{Sr}]} = \frac{[^{87}\text{Sr}]_o}{[^{86}\text{Sr}]} + \frac{[^{87}\text{Rb}]_t}{[^{86}\text{Sr}]}\,.\,(e^{\lambda t} - 1)$$

If we measure the terms corresponding to current quantities (subscripted t) for several crystals in the same rock (and so of the same age, t, which will be a constant), then a straight line graph results with the gradient ($e^{\lambda t} - 1$).

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The Author

J. H. John Peet is one of the editorial team for this journal and travelling secretary of the Biblical Creation Society. He is a graduate in Chemistry. He acknowledges the helpful discussions with Paul Garner in the preparation of this paper.

* * *

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Creation in the News

Life on Mars?

A LOT of attention has been given to *NASA* claims that they have found signs that life existed in the past on planet Mars. The announcement said that there was 'strong circumstantial evidence of possible early Martian life.' What do we make of these reports? A number of commentators observed that this report was published at the time *NASA* was awaiting a new grant for their research. They needed something spectacular to justify the huge sums they are spending in space. Not surprisingly the President of the United States responded positively: after all, it was also election year for him!

But, behind all this, what are the facts? A meteorite had been found in the Antarctica region some twelve years ago, having landed there, it is presumed, some thirteen thousand years ago. As a result of detailed analysis, it was found to contain carbonate minerals and a globule which superficially resembled a bacterium. Notice that *no* life was found; it was deduced on circumstantial evidence. The chemicals in the rock *could* have come from a living organism.

The Martian origin is also deduced rather than proven. Its mineral composition does not match that of eleven other Martian meteorites and, according to their dating techniques, was billions of years older than these others. The isotopic composition of the oxygen in the rock does match, however, and the gas in the pores of the rock (argon and carbon dioxide) resembles that on the present day planet.

However, though the structure is like that of a bacterium, it also resembles dried mud. In fact, it is much smaller than the smallest known bacterium—too small to have a nucleus and so reproduce. There are no signs of cell walls.

Living organisms are selective in their metabolism of sulphur isotopes and the ratio of these isotopes in the rock is not consistent with that in living organisms. The carbonate globules in the rock could have been derived by non-living processes. In fact, they would have required high temperatures for their production—a condition which is inconsistent with life.

The reports mentioned the presence of 'polycyclic aromatic hydrocarbons' (PAHs). These are found widely in asteroids and do not necessarily arise from living material: they occur, for example, in soot and diesel exhaust. One wonders why these chemicals would not have evaporated out of the rock during its journey to earth. Some researchers believe them to be the result of earthly contamination.

The iron compounds mentioned (magnetite and pyrite) can occur in living systems but the main deposits probably relate to inorganic processes. In fact, the conditions for the formation of the carbonate and the pyrite in living systems conflict.

As the science correspondent for the *Daily Telegraph* said, 'my doubts, if anything, have grown. The argument rests on such a long chain of improbable conjectures that it requires almost a leap of faith to find it convincing.'

The Bible does not say that God did not create life elsewhere. He is able to do so and it would be consistent with His desire for beauty. But, when we read the Bible in context, we see that the purpose of the Creation was man. The earth was prepared for man. The heavens were prepared for man. So, we believe that it is very unlikely that life will be discovered elsewhere.

Where's Eden?

WE were surprised to read an article in *Westminster Theological Journal* recently claiming to demonstrate that *'Eden's Geography erodes Flood Geology'* (J. C. Munday; 1996, 58:123-154). He first surveys the different conservative and liberal interpretations of Genesis 1–3 but concludes (p.130):

> 'It is entirely reasonable, then, no matter whether Eden's geography is real or imaginary, to seek its definition and fix the garden site as much as possible. ... the story's audience was intended to comprehend the garden's geography ... therefore, a post-Flood audience was intended to understand a pre-Flood location.'

The biblical description of the garden was examined and it was concluded (p.133) that:

> '... Eden contained rivers, touched a large water body, was a dusty arid land watered by inundation, and supported a variety of grasses, herbs, shrubs, and fruit trees, as well as various living creatures including large quadrupeds. The adjacent land of Nod east of Eden supported livestock and contained mineral ores.'

He 'locates' the garden from the biblical data and then concludes, from the geological data, that it is under 5 miles of rock. So, the biblical location cannot be real but imaginary. Therefore, the account is not historical. So, 'Eden's geography and Flood geology, both based on literalism, stand in contradiction. Some weakening of geographic actualism or Flood geology is the logically necessary outcome.'

It is a great pity that the author did not submit it to some creationists such as ourselves. He would then have avoided some obvious blunders that render his whole thesis untenable! We *are* aware of the rock structure in Mesopotamia, but we have never said where Eden was. In fact, if you read Mr. Munday's article, you will see how much he presumes. He does not know which are the rivers that are referred to in Genesis. There is a lot of guesswork in his paper.

As anyone knows, people often rename new locations after old ones. So, a number of British town names appear in America—having been taken there by the emigrants from the U.K. It would be quite reasonable for Noah and his sons to name some new rivers after the old ones of the pre-Flood days without any implication as to their original site. As we have argued in this Journal, the old earth was completely scoured away; there is little point of contact between the old and new. Peter makes this point very plainly in 2 Peter 3:6, *'the world which then was.'*

Continued on Page 29

The Geological Record

A meeting of the undermentioned was held at Bolney House, Sussex in August 1996 to discuss various issues of Flood geology. The question of whether and how far to accept the stratigraphic column was one of those issues. The group consisted of geologists and other specialists from various countries and represented a wide spectrum of views.

We affirm that the starting point for our geological thinking is the historical record in the book of Genesis, which we accept at its face value. Of specific geological significance, we are convinced that Genesis testifies that:

(1) the Earth is young and created by God;
(2) all disease, suffering, pain, carnivory and biblically-defined death evidenced in the fossil record post-dates man's Fall; and
(3) a year-long, universal Flood destroyed all flesh that dwelt upon the face of the dry land in whose nostrils was the breath of life.

As a consequence of being biblical diluvialists, we do not endorse many of the assumptions of conventional geology. For example, we reject the long time-scale. Further, we distance ourselves from the assumption that any fossil succession is the result of macroevolutionary process. Therefore, we do not necessarily accept conventional techniques of correlating rocks (for example, by means of index fossils or radiometric dating).

At the same time, it is because of our commitment to a global Flood that we would expect to be able to identify widespread evidence of catastrophism as well as global patterns of sedimentation and fossilisation. As we have gone from one locality to another looking at the rocks of the Earth, we have each individually become convinced that catastrophism is pervasive, correlations are possible and global patterns in lithology, palaeontology and chemistry really exist.

We wish to distinguish different concepts which are conflated within the 'Geologic Column' (see Figure 1):

(1) a global succession of rock types (as suggested by early catastrophist geologists), represented by a lithostratigraphic column;
(2) global successions of fossils (the best known one being the succession of first fossil appearances of the fish, amphibians, reptiles and mammals), represented by biostratigraphic columns;
(3) an absolute geological time-scale; and
(4) the chronostratigraphic column.

The last of these concepts, the chronostratigraphic column, is in turn actually a further conflation. In the conflation it is often assumed that any given lithologic unit in the lithostratigraphic column represents the same time period wherever found on the globe (that is, it is isochronous). Similar assumptions have been made for fossil units in the biostratigraphic column. These assumptions are then used to construct from the lithostratigraphic column a rock-unit stratigraphic column, with its erathems, systems, series and stages. Corresponding to the latter, finally, is a succession of time intervals, represented by the chronostratigraphic column, with its eras, periods, epochs and ages. We recognise the general validity (but are cautious about the details) of the lithostratigraphic and biostratigraphic columns, question the assumptions in the chronostratigraphic column and reject entirely the absolute geological time-scale. As a consequence, we prefer to utilise lithostratigraphic terms (for example, sequences, groups, formations, beds) over time-rock terms (for example, erathem, system, series, stage and associated upper, mid and lower) and reject

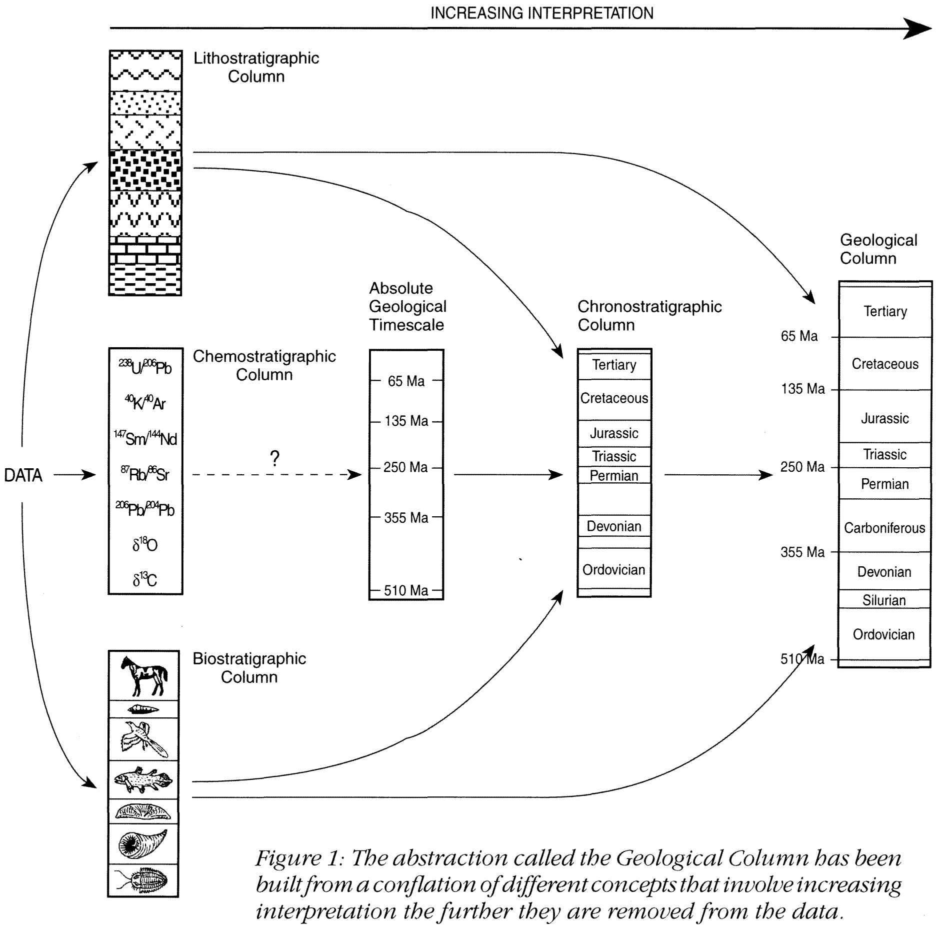

Figure 1: The abstraction called the Geological Column has been built from a conflation of different concepts that involve increasing interpretation the further they are removed from the data.

entirely the use of chronostratigraphic terms (for example, era, period, epoch, age and associated late, middle and early).

We believe this to be a sound basis for further research in creationist geology.

Andrew A. Snelling, Brisbane, Australia.
Joachim Scheven, Hagen, Germany.
Paul Garner, Soham, Ely, U.K.
Martin Ernst, Kirchzarten, Germany.
Steven A. Austin, San Diego, U.S.A.
Michael Garton, London, U.K.
Esther Scheven, Frankfurt, Germany
Kurt P. Wise, Dayton, Tennessee, U.S.A.
David Tyler, Hyde, U.K.

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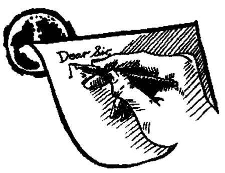
Continued from Page 27

Noah's Ark again!

REGULAR readers will recall our comments (*Origins*,1991, 4(10):14) on the claims by David Fasold that he had found Noah's Ark at a new site in Turkey. We raised serious doubts about this and received some bitter attacks from Mr. Fasold at the time. We responded to this later (*Origins*, 1996, 6(15):26).

Readers will be interested to know that Mr. Fasold has now retracted his claims (*'Bogus 'Noah's Ark' from Turkey Exposed as a Common Geological Structure'*, Journal of Geoscience Education, 1996, 44:439-444). It was good to see this retraction by Mr. Fasold. However, a Jonathan Gray and Ron Wyatt are still publicising this find as a fact. We would wish to advise our readers to treat these claims with continuing scepticism. We hope these two men will similarly acknowledge the realities before long.



Correspondence

Sylvia Baker: *Reflections on the Rioja Geological Excursion.*

I had anticipated that the excursion would be both interesting and stimulating, but I had not expected it to have such a profound effect on my thinking. Perhaps I can best illustrate this effect in the context of my work as the Head of a Christian school. For years I have been attempting to think different disciplines through with the aim of teaching them in a Christ-centred and biblical way, so that some of my young pupils would be stimulated to take these disciplines further. This has worked reasonably well in a number of different subject areas and former pupils of the school are now working at PhD and Masters level in several universities, standing for Christ and hopefully bringing their Christian training to bear on their subjects. However, this was not true of geology. I would never have encouraged any of the young people forward in that subject. As an academic discipline in secular universities, it appeared to be totally in the hands of the devil, to such an extent that it would be virtually impossible for a Christian to work in that setting without seriously compromising their beliefs.

On the other hand, creationists did not seem to provide a proper framework for academic study in geology either. Some seemed to be constantly struggling to stem the tide of evil coming from the secular geologists; others seemed to be preoccupied with finding 'evidences' for the Flood. Although they appeared to be based on the Bible's teaching about the Flood, neither of these approaches succeeded in providing a positive Christian study of geology that could move forward in the way that I could see happening in other disciplines.

Now that I have been able to discuss the Precambrian/Palæozoic Flood model in some detail while at the same time looking at some field evidence for it, I feel completely differently. I can now see that academically rigorous work done by secular geologists does not need to be dismissed or even greatly reinterpreted. The simple matter of collapsing the time scale from millions of years to perhaps 200 years brings all that they have discovered within the scope of what the Bible teaches. A very slight shift of perspective—the timing—reveals their discoveries to be portraying a terrible judgment of God. The idea that the Precambrian represents the total and terrifying destruction of the pre-Flood world and that much of the later geological column summarises a struggle as the Earth attempted to recover from the disaster, far from watering down the 'Flood' message, does just the reverse.

I am now tempted to persuade all my young pupils to become geologists! It is as though the subject has been given back to us.

Mr. Philip Schroeder, *Germany.*

I am writing to tell you how much our students enjoy your excellent magazine, *Origins*... It is very informative and we appreciate receiving it. It has such a wealth of information that we would like to make it more usable for our students.

Mr. David Legg, *Middlesex.*

Thank you for the BCS Journal, *Origins*. It is both attractively and immaculately presented. Other journals that I read merely get dipped into, but I usually read Origins from cover to cover. The articles and papers appear to be of increasing quality and many useful issues have been aired.

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